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CORRECTIVE MEASURES STUDY REPORT COMBINED SOLID WASTE MANAGEMENT UNIT 9 (SWMU 9) ZONE H CNC CHARLESTON SC
3/1/2004
CH2M HILL

CORRECTIVE MEASURES STUDY REPORT

Combined SWMU 9, Zone H

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

CH2M Jones

March 2004

Contract N62467-99-C-0960

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Revision 1
Contract N62467-99-C-0960
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Certification Page for Corrective Measures Study Report (Revision 1) — Combined SWMU 9, Zone H

I, Dean Williamson, certify that this report has been prepared under my direct supervision. The data and information are, to the best of my knowledge, accurate and correct, and the report has been prepared in accordance with current standards of practice for engineering.

South Carolina

P.E. No. 21428

Dean Williamson

Dean Williamson, P.E.

3/3/2004

Date

Contents

Appendices

Acronyms and Abbreviations

ACL	alternate concentration level
ANOVA	analysis of variance
AOC	area of concern
AWQC	ambient water quality criteria
BCT	BRAC Cleanup Team
BEQ	benzo(a)pyrene equivalent
BMP	best management practice
BRA	baseline risk assessment
BRAC	Base Realignment and Closure Act
BRC	background reference concentration
CA	corrective action
CAO	corrective action objectives
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeter per second
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
COPC	chemical of potential concern
DET	Environmental Detachment Charleston
EnSafe	EnSafe Inc.
EPA	U.S. Environmental Protection Agency
ESDSOPQAM	EPA Environmental Services Division *Standard Operating Procedures and Quality Assurance Manual*
FID	flame ionization detector
ft bls	feet below land surface
GRO	gasoline-range organic

HHRA	human health risk assessment
HI	hazard index
LTM	long-term monitoring
LUC	land use control
LUCIP	land use control implementation plan
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
MCL	maximum contaminant level
MCS	media cleanup standard
mg/kg	milligrams per kilogram
NAVBASE	Naval Base
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pg/kg	picogram per kilogram
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QC	quality control
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAA	satellite accumulation area
SCDHEC	South Carolina Department of Health and Environmental Control
SOB	Statement of Basis
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TEQ	2,3,7,8-TCDD equivalency quotient

UCL_{95}	95% Upper Confidence Limit
VOC	volatile organic compound

Section 1.0

1.0 Introduction

In 1993, Naval Base (NAVBASE) Charleston was added to the list of bases scheduled for closure as part of the Defense Base Realignment and Closure Act (BRAC), which regulates closure and transition of property to the community. The Charleston Naval Complex (CNC) was formed as a result of the dis-establishment of the Charleston Naval Shipyard and NAVBASE on April 1, 1996.

Corrective Action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA) with the South Carolina Department of Health and Environmental Control (SCDHEC) as the lead agency for CA activities at the CNC. All RCRA CA activities are performed in accordance with the Final Permit (Permit No. SC0 170 022 560). In April 2000, CH2M-Jones was awarded a contract to provide environmental investigation and remediation services at the CNC.

RCRA Facility Investigation (RFI) Reports (EnSafe Inc. [EnSafe], 1998; EnSafe, 1999) and Corrective Measures Study (CMS) Work Plan (CH2M-Jones, 2001) were prepared for Combined Solid Waste Management Unit (SWMU) 9 of the CNC. Combined SWMU 9 refers to SWMU 9, which is a closed landfill, and the SWMUs and areas of concern (AOCs) located on the landfill footprint: SWMUs 19, 20, and 121 and AOCs 637, 649, 650, and 651. This CMS Report has been prepared by CH2M-Jones to complete the next stage of the CA process for Combined SWMU 9.

Upon completion of the CMS, a Statement of Basis (SOB) that documents the CMS findings and presents the preferred corrective measure alternative will be made available for public comment.

1.1 Purpose

The primary purpose of this CMS report is to identify, evaluate, and recommend a corrective measure for Combined SWMU 9. In accordance with the RCRA Corrective Action Program administered by the State of South Carolina, presumptive remedies are the preferred corrective measures for common categories of sites, such as landfills, based on U.S. Environmental Protection Agency's (EPA's) scientific and engineering evaluation of performance data on technology implementation (EPA, 1996). The presumptive remedy for landfills is containment, i.e., leaving the landfill waste in place, based on EPA's past and repeated conclusion that for certain types of landfills, containment is effective, easily implemented, and provides cost savings. Therefore, evaluation of Combined SWMU 9 and the applicable corrective action objectives (CAOs) (Section 2.0 and 3.0) will determine whether the containment presumptive remedy should be the corrective measure alternative for Combined SWMU 9.

Combined SWMU 9 is described in detail in Section 2.0. Figure 1-1 illustrates the location and layout of Combined SWMU 9 in the CNC.

1.2 Scope

The following tasks will be performed as part of the CMS scope:

- Develop CAOs for various environmental media at Combined SWMU 9, based on the detected chemical concentrations, baseline ecological and human health risk assessments (HHRAs), and regulatory standards and requirements.
- Develop the presumptive remedy scope for Combined SWMU 9 in accordance with the presumptive remedy approach for military landfills.
- Identify and screen potentially applicable corrective measures technologies and processes for implementing the presumptive remedy and achieving the CAOs for the site.
- Develop corrective measure components using a combination of feasible corrective measures technologies. The corrective measure components will be screened for feasibility based on the following criteria:
  - Protection of human health and the environment
  - Attainment of CAOs
  - Source control and mitigation of future releases
- Evaluate the feasible corrective measure components on the technical, environmental, human health, regulatory, and institutional criteria. The specific evaluation criteria are:
  - Long-term reliability and effectiveness
  - Reduction in toxicity, mobility, and volume of wastes
  - Short-term effectiveness
  - Implementability
  - State and community acceptance
  - Cost

Following the review of the CMS by SCDHEC and the BRAC Cleanup Team (BCT), the state and community acceptance will be determined.

- Prepare a report to present the CMS assessment methodology and results.

1.3 Organization of Report

This CMS Report consists of the following sections, including this introductory section. The 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).

1.0 Introduction — Provides an introduction and the purpose, scope, and organization of the document.

2.0 Description of Current Conditions — Presents the current conditions of Combined SWMU 9, including background information about the site, a summary of the nature and extent of contamination, fate and transport, and the baseline risk assessment (BRA).

3.0 Corrective Action Objectives — Presents the corrective measure objectives, including the media cleanup standards (MCSs) derived from the promulgated standards, risk-based standards, and other applicable guidance.

4.0 Corrective Measure Development — Identifies, describes, and evaluates the presumptive remedy components that are potentially applicable for the remediation of Combined SWMU 9.

5.0 Detailed Development of Corrective Measure — Presents a detailed development of the components described in Section 4.0.

6.0 References — Lists the references used in this document.

Appendix A contains the basis for delineating the northern boundary of Combined SWMU 9 and a copy of Figure 4.1.1. from the *Zone H RFI Report, Revision 0*.

Appendix B contains the soil gas survey results.

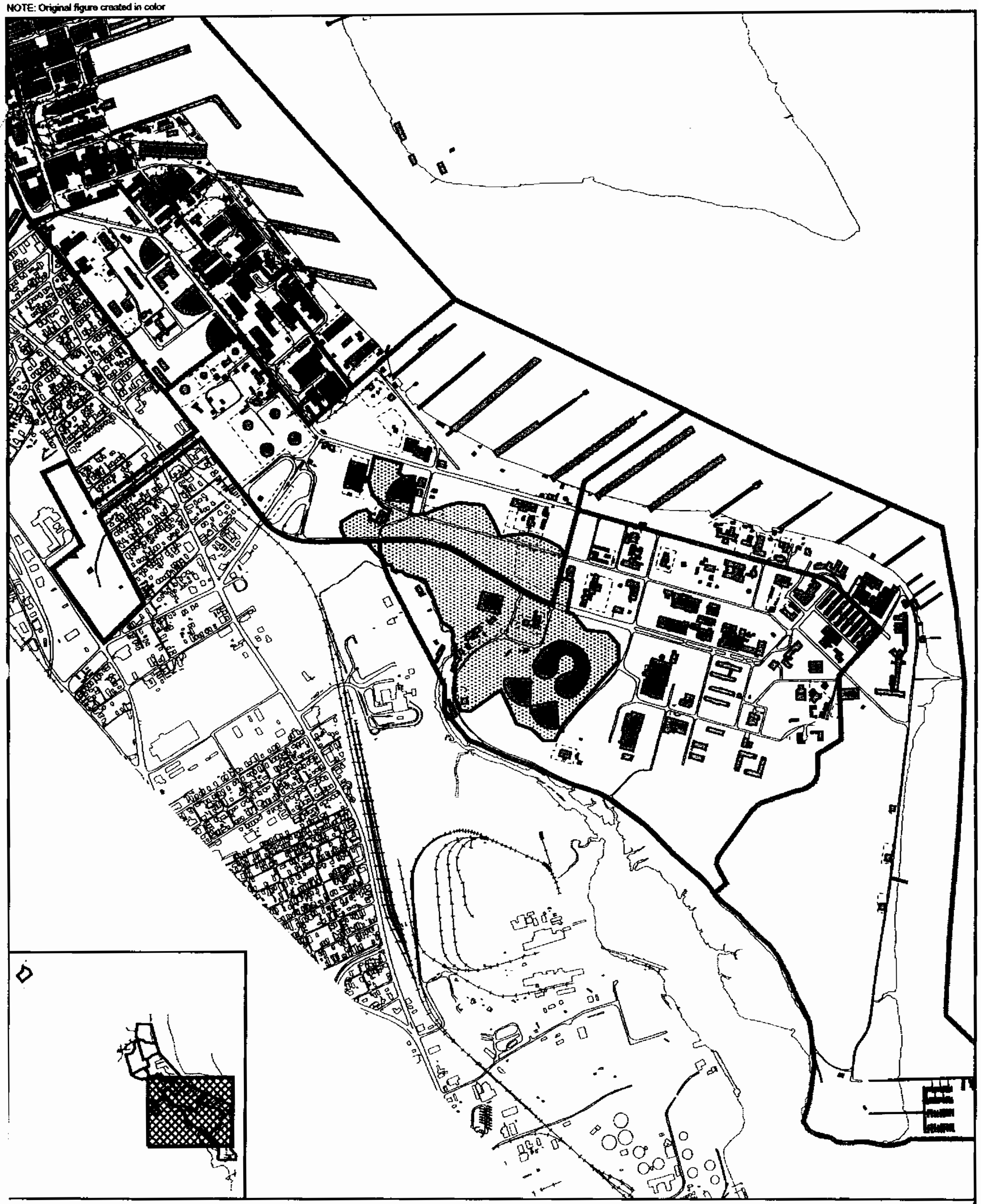
Appendix C contains the cost estimates for the corrective measure components.

Appendix D contains the 95% Upper Confidence Limit [UCL_{95}] summaries.

Appendix E contains the Responses to SCDHEC Comments on the *CMS Report, Combined SWMU 9, Zone H, Revision 0* (CH2M HILL, 2003).

All tables and figures appear at the end of their respective sections.

NOTE: Original figure created in color



Railroads
Buildings
Landfill

N

0 1000 2000 Feet

1 inch = 1491.82 feet

Figure 1-1
Location of Combined SWMU 9
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

Section 2.0

2.0 Description of Current Conditions

Combined SWMU 9 includes an approximately 120-acre closed landfill at the CNC's southern end that is generally bounded by Shipyard Creek to the southwest, Hobson Avenue to the northeast, and Holland Street to the southeast. The areas designated as Combined SWMU 9 during the RFI included SWMU 9, which is the landfill itself, and the following SWMUs and AOCs located on the landfill footprint: SWMUs 19, 20, and 121 and AOCs 637, 649, 650, 651, and 654.

The SWMUs and AOCs that are identified as Combined SWMU 9 for the purposes of this CMS are SWMUs 9, 19, 20 and 121 and AOCs 637, 649, 650 and 651. The delineation of the Combined SWMU 9 boundary, along with an explanation for the variation of sites between the Combined SWMU 9 RFI and the Combined SWMU 9 CMS, are detailed in Section 2.1. Figure 2-1 illustrates the estimated boundary of Combined SWMU 9 for the CMS.

All of the SWMUs and AOCs that were part of the Combined SWMU 9 RFI and that are part of the Combined SWMU 9 CMS are currently inactive and are not designated for use in the future.

2.1 Combined SWMU 9 Boundary

The Combined SWMU 9 landfill area investigated during the RFI in 1996 encompassed SWMUs 9, 19, 20, and 121 and AOCs 637, 649, 650, 651 and 654. AOC 654 was excluded from the CMS process because it was granted No Further Action (NFA) status on August 28, 1997. Therefore, the Combined SWMU 9 evaluated under this CMS effort includes SWMUs 9, 19, 20, and 121 and AOCs 637, 649, 650, and 651. Additionally, AOC 706 was included in the footprint of Combined SWMU 9 based on a recommendation by SCDHEC as part of the comments on the Revision 0 Combined SWMU 9 CMS Report and on historical information indicating the presence of household wastes in trenches dug near the AOC 706 boundary.

As part of the Combined SWMU 9 CMS, the available historical data were evaluated to finalize the northern boundary location. These historical data included the Zone H RFI (EnSafe, 1998), the geophysical investigation conducted by the Navy's Environmental Detachment Charleston (DET) (SUPSHIP, 1999), historical aerial photos, historical site maps, and other work completed adjacent to the landfill (e.g., SWMU 8 Interim Measure).

Subsequent to the RFI activities, a geophysical and intrusive investigation was conducted by the DET to delineate the northern boundary of Combined SWMU 9. This investigation included a visual inspection for materials typical of landfills (e.g., garbage, construction debris, glass) using test pits dug on the northern side of the landfill. The results of the visual inspection delineated the northern boundary of Combined SWMU 9, which is shown on Figure 2-1. The basis for the delineation of the northern boundary is presented in Appendix A of this CMS Report

2.2 Combined SWMU 9 Background

The SWMU 9 landfill was used for the disposal of industrial and domestic solid waste generated at the CNC from the 1930s until the early 1970s. The landfill contains primarily municipal, solid waste-type wastes (e.g., medical waste, empty oil containers, empty Freon tanks, cargo netting, gas masks, concrete, wood, and domestic refuse), as well as industrial solid wastes. Industrial wastes disposed in the landfill reportedly included paint, varnish, and metal sludges from former industrial operations at the CNC. The landfill was closed by placing a soil cover over the landfill area.

The landfill was operated as an area fill (i.e., no trenches were dug). To reduce volume, the landfilling activities reportedly included periodic burning of landfill wastes. Ash and unburned material were left in the landfill. On the basis of the site investigation data, the depth of the landfill wastes is approximately 10 feet or less.

Prior to SWMU 9 landfilling activities, the area was a tidal marsh bordering Shipyard Creek. Wastes were deposited directly into the marsh and were often flooded by high tides. Cover material was reportedly applied on an irregular "as-available" basis. Soils from building excavations, spoil dredged from the river, and bottom ash from the power plant may have been used as cover material (EnSafe/Allen & Hoshall, 1995).

Following the landfill closure, several areas that were located within the SWMU 9 boundary were used for various activities, including waste management. These locations were designated as SWMUs and AOCs under the RCRA Corrective Action Program for the CNC and are included in Combined SWMU 9 in this CMS. A brief description of each of these SWMUs and AOCs is presented in Section 2.2.1 through Section 2.2.4.

Combined SWMU 9 is currently used for various purposes and includes large grassy, open areas and areas covered with small woods and brush. The United States Border Patrol Training Academy (USBPTA), a current tenant at the CNC, frequently uses the running track located on the landfill for physical conditioning. Several buildings are located over Combined SWMU 9 (e.g., Buildings 161, 246, 641, 650, 672, 673, and 674) and many of these buildings are occupied by tenants. The current uses of Combined SWMU 9 are shown on Figure 2-2.

The current land uses at Combined SWMU 9 are expected to continue. The entire Combined SWMU 9 site is scheduled to include a deed restriction, limiting future development or land use to the current uses.

2.2.1 SWMU 19 – Solid Waste Transfer Station

SWMU 19 was the solid waste transfer station that temporarily stored solid waste before it was transported offsite. The solid waste included dry trash, which was compacted, tires, and empty 55-gallon drums. These wastes were stored on bare ground. The location and layout of SWMU 19 within the Combined SWMU 9 area is shown on Figures 2-1 and 2-3.

2.2.2 SWMU 20 – Former Waste Disposal Area

Beginning in 1985, SWMU 20 was used for the temporary storage of waste, such as cardboard boxes, batteries, concrete, wood, and sand-blasting residue. These wastes were reportedly stored on the ground without any containment. The location and layout of SWMU 20 within the Combined SWMU 9 area is shown on Figures 2-1 and 2-4.

2.2.3 SWMU 121 – Former Satellite Accumulation Area for Recycling Operations

SWMU 121 consisted of a recyclable material management building (Building 801) and an associated satellite accumulation area (SAA). Building 801 was used for collecting, sorting, and storing recyclable materials, and the associated SAA was used for accumulation of hazardous wastes. The SAA consisted of an 8-by-8-foot sheet-metal shed, with a concrete floor on which hazardous waste was accumulated. Aerosol paint cans were reportedly crushed inside the unit and paint residues were collected in a 55-gallon drum. A separate drum was used for collecting waste oil. The SAA did not include a secondary containment structure. The location and layout of SWMU 121 is shown on Figures 2-1 and 2-5. The unit has been removed from service and the metal shed has been removed.

2.2.4 AOC 637 – Former Burning Dump

AOC 637 was not originally investigated as part of Combined SWMU 9, but it is located within the boundary of the SWMU 9 landfill and considered an integral part of Combined

SWMU 9 for the CMS. AOC 637 is located between Dyess Avenue and Bainbridge Avenue, directly south of SWMU 8 and AOC 636. AOC 637, a former disposal area referred to as a "burning dump," is similar in character to SWMU 9.

The area was used from the late 1940s to the early 1950s. The area has since been filled with dredge spoil and is now a gravel-covered parking area. The location of AOC 637 is shown on Figure 2-1 and 2-6.

2.2.5 AOC 649, AOC 650, and AOC 651

Due to their proximity to each other, AOCs 649, 650, and 651 are considered as one study area and were investigated as one site during the RFI. These AOCs consist of the following:

- AOC 649 - Former Braswell Storage Area,
- AOC 650 - Former Metal Trades Storage Area, and
- AOC 651 - Former Sandblaster's Storage Area.

The locations and layout of AOCs 649, 650, and 651 are shown on Figure 2-1 and 2-7.

AOC 649, known as the former Braswell Storage Area, is located east of Building 672. The site was used to store sandblast media, welding supplies, and other supplies used in ship repair. Material was stored for an unknown length of time during the 1970s. The area is currently a grassy field with some patches of gravel.

AOC 650, the former Metal Trades Storage Area, is located east of Building 672. This site was used to store unknown supplies used in ship repair. The exact dates of operation are unknown, but maps indicate that the area was in operation during the 1970s. The area is currently a grassy field with some patches of gravel.

AOC 651, the former Sandblaster's Storage Area, is located east of Building 672. This site was used to store sandblast media, presumably resulting from ship repair. The area was in operation from the 1970s until 1991. The area is currently a grassy field with some patches of gravel. All sandblasting media was reportedly removed from the site prior to closure of the CNC.

2.2.6 Combined SWMU 9 Groundwater

This CMS addresses groundwater beneath Combined SWMU 9 as one single unit for the purposes of characterization, risk assessment, and remedy selection. As such, the following discussion of SWMU 9 groundwater is a combined evaluation and presentation of groundwater data collected during the RFI for SWMUs and AOCs located within Combined SWMU 9.

The upper most lithologic units encountered at SWMU 9 are the Wando and Ashley Formations. The Ashley Formation is the lower of the two units. It consists of a phosphatic marl and is encountered at depths ranging from approximately 34 to 73 feet below land surface (ft bls) within the footprint of SWMU 9. It is a regional confining unit that inhibits the vertical migration of groundwater from the overlying Wando Formation. Within the footprint of SWMU 9, the Wando Formation consists of upper and lower silty sand, separated by a highly plastic silty clay to clay (identified as marsh clay). Above the Wando Formation at the surface is fill material up to 10 feet thick.

Groundwater occurs within the upper sand (identified as shallow groundwater) and lower sand (identified as deep groundwater) of the Wando Formation under water table and poorly confined conditions, respectively. The marsh clays act as a local aquitard that impedes flow between the sand units. Shallow groundwater was encountered in the upper sands at depths ranging from ground surface in the marsh areas to approximately 5 ft bls. The potentiometric surface of upper silty sand for June 2, 2002, is shown on Figure 2-8. The groundwater beneath the southeastern portion of SWMU 9 flows radially to the north, west, and south, while at the northwestern portion of SWMU 9, groundwater flows radially to the north, south, and east. The groundwater flow in the central portion of SWMU 9 forms a trough that appears to flow to the north/northeast towards the Cooper River.

The potentiometric surface of deeper groundwater in the lower sand for June 2, 2002, is shown on Figure 2-9. The deep groundwater flow of the lower sand is radially to the north, west, east, and south, with the high in the southwestern portion of SWMU 9 and Zone H.

2.2.7 Nature and Extent of Contamination

The nature and extent of contamination at the site was estimated primarily based on the results of the following activities:

- RFI conducted in 1996,
- Two post-RFI groundwater sampling events in 2002, and
- Geophysical and intrusive investigation conducted by the DET in 1999.

As indicated in the Zone H RFI Report, many of the subsurface soil samples proposed for collection were not collected during the RFI, due to the shallow depth of the groundwater encountered. No subsurface soil COCs were identified in the Zone H RFI. The geophysical and intrusive investigation by the DET was conducted to visually identify the northern limits of the landfill wastes. The results of this investigation are presented in Appendix A. These results were utilized in establishing the northern boundary of Combined SWMU 9 as depicted on Figure 2-1.

In addition, a soil gas survey was conducted during the RFI to measure potential gaseous emissions (e.g., volatile organic compounds [VOCs] and methane) from the landfill. The results of the soil gas survey are detailed in Appendix B.

A brief overview of the RFI results and the nature and extent of soil contamination is presented in Sections 2.2.7.1 through 2.2.7.6. Groundwater beneath Combined SWMU 9 was investigated and evaluated. The groundwater investigation results, including the nature and extent of contamination, is presented in Section 2.2.7.8.

In addition, the chemicals of concern (COCs) identified in the Zone H RFI report for the SWMUs and AOCs within Combined SWMU 9 are discussed below to determine if they are considered COCs for the industrial land use scenario.

2.2.7.1 SWMU 9

During the RFI activities, 11 trenches were excavated at SWMU 9 to visually examine the landfill waste contents and to delineate the landfill boundary. In addition, test pits were excavated by the DET in 1999 to identify the northern boundary of the landfill (discussed in Section 2.1). A copy of Figure 4.1.1 of the Zone H RFI Report that shows these trenches has been included in Appendix A.

One subsurface soil sample was typically collected from 2 to 5 ft bls from each trench for analytical analyses. The analytical results showed the presence of polychlorinated biphenyls (PCBs) and semivolatile organic compounds (SVOCs).

Thirty hand-auger borings were advanced to investigate the existing landfill cover thickness at SWMU 9. The results showed the soil cover thickness ranged from 0.5 feet to 6.25 feet. The shallower thickness of soil cover was observed in the southern and western sides of the landfill area. An approximated soil cover thickness contour map is presented on Figure 2-10.

2.2.7.2 SWMU 19

A total of 17 surface soil samples and 2 subsurface soil samples were collected from SWMU 19. These samples were analyzed for various metal and organic analytes.

The RFI report identified benzo(a)pyrene equivalents (BEQs), Aroclor 1254, Aroclor 1260, arsenic, beryllium, copper, nickel, and zinc as surface soil COCs. However, based on further evaluation using current chemical of potential concern (COPC) screening criteria, none of these COCs were retained as COPCs in surface soil for the industrial land use scenario. The nature of occurrence and the relevance of the COCs identified during the RFI at this site are further discussed below.

2.2.7.2.1 BEQs

BEQ detections in surface soil ranged from 310 micrograms per kilogram (μg/kg) to 1,060 μg/kg at SWMU 19, as shown in Table 2-1. However, none of the detections exceeded the surface soil CNC BEQ sitewide reference concentration of 1,304 μg/kg. For this reason, BEQs are not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.2 Aroclor 1254

Aroclor 1254 was detected in 1 out of 17 surface soil samples, as shown in Table 2-1. The detection, at a concentration of 2.3 milligrams per kilogram (mg/kg) at location H019SB007, did not exceed the industrial risk-based concentration (RBC) of 2.9 mg/kg. For this reason, Aroclor 1254 is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.3 Aroclor 1260

Aroclor 1260 was detected in 11 out of 17 surface soil samples, at concentrations ranging from 0.032 mg/kg to 0.56 mg/kg, as shown in Table 2-1. None of these detections exceeded the industrial RBC of 2.9 mg/kg. For this reason, Aroclor 1260 is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.4 Arsenic

Arsenic was detected in 13 out of 17 surface soil samples, at concentrations ranging from 3 mg/kg to 22.1 mg/kg, as shown in Table 2-1. Two of the detections, at concentrations of 21.4 mg/kg and 22.1 mg/kg at locations H019SB003 and H019SB009, respectively, exceeded both the industrial RBC and the Zone H surface soil maximum background concentration for arsenic of 18 mg/kg, but not the maximum Zone G background arsenic concentration of 25 mg/kg. The estimated exposure concentration for arsenic (using a UCL_{95} calculation) is 15 mg/kg, as shown in Appendix D. For sites where background arsenic concentrations exceed the RBC, EPA Region IV typically considers an arsenic concentration of 20 mg/kg as acceptable for unrestricted land use and a concentration of 270 mg/kg as acceptable for industrial land use. Based on these considerations, arsenic is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.5 Beryllium

Beryllium was detected in 15 out of 17 surface soil samples, at concentrations ranging from 0.15 mg/kg to 3 mg/kg, as shown in Table 2-1. None of these detections exceeded the industrial RBC of 410 mg/kg (hazard index [HI] = 0.1). For this reason, beryllium is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.6 Copper

Copper was detected in 15 out of 17 surface soil samples, at concentrations ranging from 5.9 mg/kg to 3,040 mg/kg, as shown in Table 2-1. None of these detections exceeded the industrial RBC of 8,200 mg/kg (HI = 0.1). For this reason, copper is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.7 Nickel

Nickel was detected in 15 out of 17 surface soil samples, at concentrations ranging from 2.7 mg/kg to 282 mg/kg, as shown in Table 2-1. None of these detections exceeded the industrial RBC of 4,100 mg/kg (HI = 0.1). For this reason, nickel is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.2.8 Zinc

Zinc was detected in 15 out of 16 surface soil samples, at concentrations ranging from 12.3 mg/kg to 2,800 mg/kg, as shown in Table 2-1. None of these detections exceeded the industrial RBC of 61,000 mg/kg (HI = 0.1). For this reason, zinc is not considered a COC in surface soil at SWMU 19 for the industrial land use scenario.

2.2.7.3 SWMU 20

A total of 11 surface soil (0-1 ft bls interval) and 1 subsurface soil samples were collected during the RFI at SWMU 20. These samples were analyzed for VOCs and SVOCs, and two of the samples were analyzed for dioxins.

The RFI report identified BEQs as a surface soil COC. However, based on further evaluation using current screening criteria, BEQs were not retained as an industrial land use COC in surface soil. The nature of occurrence and the relevance of this COC identified during the RFI at SWMU 20 is further discussed below.

2.2.7.3.1 BEQs

BEQs were detected in 10 out of 11 surface soil samples, at concentrations ranging from 316.7 µg/kg to 1,268.3 µg/kg, as shown in Table 2-2. However, none of the detections exceeded the surface soil CNC BEQ sitewide reference concentration of 1,304 µg/kg. For this reason, BEQs are not considered a COC in surface soil at SWMU 20 for the industrial land use scenario.

2.2.7.4 SWMU 121

Surface soil samples were collected at 17 sampling locations at SWMU 121. Of these samples, 5 samples were analyzed for VOCs, cyanide, pesticides, and dioxins, and 16 samples were analyzed for SVOCs, PCBs, and metals.

A summary of the analytical results for the COPCs at SWMU 121 is presented in Table 2-3.

The RFI report identified BEQs, Aroclor 1254, arsenic, and beryllium as surface soil COCs. Based on further evaluation using current screening criteria, only BEQs are retained as a COC in surface soil for the industrial land use scenario. The nature of occurrence and the relevance of these COCs identified during the RFI at this site are further discussed below.

2.2.7.4.1 BEQs

BEQs were detected in 12 out of 17 surface soil samples at SWMU 121, at concentrations ranging from 316.3 µg/kg to 2,524.9 µg/kg, as shown in Table 2-3. Two of the detections, at concentrations of 2,106.7 µg/kg and 2,524.9 µg/kg at locations H121SB013 and H121SB011, respectively, exceeded the surface soil CNC BEQ sitewide reference concentration of 1,304 µg/kg. The estimated exposure concentration for BEQs is 1,051 µg/kg (based on a UCL_{95} calculation), as shown in Appendix D. This value exceeds the industrial land use RBC of 780 µg/kg for benzo(a)pyrene. Therefore, BEQs are retained as a COC at SWMU 121 for the industrial land use scenario. Because of the isolated location of this site and the limited number of samples that exceed the surface soil CNC BEQ sitewide reference concentration, no further active remediation is expected for this area.

2.2.7.4.2 Arsenic

Arsenic was detected in 11 out of 16 surface soil samples, at concentrations ranging from 3.5 mg/kg to 18.7 mg/kg, as shown in Table 2-3. One of the detections, at a concentration of 18.7 mg/kg at location H121SB004, slightly exceeds the Zone H surface soil maximum background concentration for arsenic of 18 mg/kg, but not the maximum Zone G background arsenic concentration of 25 mg/kg. The estimated exposure concentration for arsenic (based on a UCL_{95} calculation) is 8.9 mg/kg, as shown in Appendix D. For sites where background arsenic concentrations exceed the RBC, EPA Region IV typically considers an arsenic concentration of 20 mg/kg as acceptable for unrestricted land use and a concentration of 270 mg/kg as acceptable for the industrial land use scenario. For this reason, arsenic is not considered a COC in surface soil at SWMU 121.

2.2.7.4.3 Beryllium

Beryllium was detected in all 16 surface soil samples, at concentrations ranging from 0.16 mg/kg to 14.6 mg/kg, as shown in Table 2-3. None of these detections exceeded the industrial RBC of 410 mg/kg (HI = 0.1). For this reason, beryllium is not considered a COC in surface soil at SWMU 121 for the industrial land use scenario.

2.2.7.4.4 Aroclor 1254

Aroclor 1254 was detected in 6 out of 16 surface soil samples, as shown in Table 2-3. One of the detections, at a concentration of 4.3 mg/kg at location H121SB016, exceeded the industrial RBC of 2.9 mg/kg. The estimated exposure concentration for Aroclor 1254 is 0.80 mg/kg (based on a UCL_{95} calculation), as shown in Appendix D, which does not exceed the industrial RBC of 2.9 mg/kg. For this reason, Aroclor 1254 is not considered a COC in surface soil at SWMU 121 for the industrial land use scenario.

2.2.7.5 AOC 637

A total of seven surface soil samples and two subsurface soil samples were collected from seven soil borings during the RFI at AOC 637. The samples were collected during two sampling events. During the first sampling event, samples were analyzed for VOCs, SVOCs, metals, cyanide, pesticides/PCBs, and explosives/propellants. The samples collected during the second sampling event were analyzed for SVOCs, metals, and pesticides/PCBs. Two surface soil duplicate samples were collected and analyzed for VOCs, SVOCs, metals, pesticides/PCBs, organophosphorus pesticides, cyanide, and dioxins. A summary of the analytical results for the COPCs at AOC 637 is presented in Table 2-4.

The RFI report identified arsenic, BEQs, hydrazine, and thallium as surface soil COCs at the site. However, based on further evaluation using current screening criteria, arsenic, BEQs, hydrazine, and thallium were not retained as surface soil COCs. The nature of occurrence and the relevance of these COCs identified during the RFI at AOC 637 are further discussed below.

2.2.7.5.1 Arsenic

Arsenic was detected in all surface soil samples collected at AOC 637, at concentrations ranging from 4.2 mg/kg to 24.4 mg/kg, as shown in Table 2-4. The detected concentrations for arsenic are within the range of background concentration for arsenic for Zone G surface soil (maximum background concentration for arsenic = 25 mg/kg). With the exception of the concentration of 24.4 mg/kg detected at location G637SB007, all detected arsenic concentrations are also below the maximum Zone H surface soil background concentration for arsenic of 18 mg/kg. Therefore, arsenic is not considered a COC in surface soil at AOC 637 for the industrial land use scenario.

2.2.7.5.2 BEQs

BEQs were detected in five of the seven surface soil samples and in one of the two subsurface soil samples collected at AOC 637. The detected surface soil BEQ concentrations ranged from 6.4 µg/kg to 21.6 µg/kg, as shown in Table 2-4. The only subsurface soil BEQ detection was at a concentration of 94 µg/kg at location G637SB006. None of the detected surface soil BEQ concentrations exceeded the industrial RBC of 780 µg/kg for benzo(a)pyrene or the surface soil CNC BEQ sitewide reference concentration of 1,304 µg/kg. The subsurface soil BEQ detection was also below the subsurface soil CNC BEQ sitewide reference concentration of 1,400 µg/kg. For these reasons, BEQs are not considered a COC in surface soil at AOC 637 for the industrial land use scenario.

2.2.7.5.3 Hydrazine

Hydrazine was detected in all five of the surface soil samples collected at AOC 637, at concentrations ranging from 0.118 mg/kg to 0.213 mg/kg, as shown in Table 2-4. None of the detections exceeded the hydrazine industrial RBC of 1.9 mg/kg. Further, the reported detections of hydrazine during the RFI activities at CNC were determined to be a laboratory analytical method artifact and not true detections (CH2M-Jones, 2002b). For these reasons, hydrazine is not considered a COC in surface soil at AOC 637 for the industrial land use scenario.

2.2.7.5.4 Thallium

Thallium was detected in all the surface soil samples collected at AOC 637, at concentrations ranging from 0.37 mg/kg to 1.2 mg/kg, as shown in Table 2-4. None of the detections exceeded the thallium industrial RBC of 14 mg/kg (HI =0.1). Thallium concentrations detected in the subsurface soil samples collected at AOC 637 were below the maximum subsurface soil background concentration for thallium for Zone G of 1 mg/kg and for Zone H of 1.1 mg/kg. For these reasons, thallium is not considered a COC in surface soil at AOC 637 for the industrial land use scenario.

2.2.7.6 AOC 649, AOC 650, and AOC 651

AOCs 649, 650, and 651 were considered as one study area during the RFI. A total of 19 surface soils samples were collected. All soil samples collected from AOCs 649, 650, and 651 were analyzed for SVOCs, cyanide, PCBs, metals, and pesticides. In addition, 9 of the 19 samples were analyzed for VOCs.

A summary of the analytical results for the COPCs at AOCs 649, 650 and 651 is presented in Table 2-5.

2.2.7.6.1 AOC 649

The RFI report identified BEQs as a surface soil COC at AOC 649. However, based on further evaluation using current COPC screening criteria, BEQs were not retained as a surface soil COC for the industrial land use scenario. The nature of occurrence and the relevance of this COC identified during the RFI at AOC 649 are further discussed below.

2.2.7.6.1.1 BEQs

BEQs were detected in 5 out of 10 surface soil samples at AOC 649, at concentrations ranging from 313.7 μg/kg to 531.4 μg/kg, as shown in Table 2-5. These detections are below the industrial RBC of 780 μg/kg for benzo(a)pyrene and the surface soil CNC BEQ sitewide reference concentration of 1,304 μg/kg. For this reason, BEQs are not considered a COC in surface soil at AOC 649 for the industrial land use scenario.

2.2.7.6.2 AOC 650

The RFI report identified BEQs and Aroclor 1254 as surface soil COCs at AOC 650. However, based on further evaluation using current screening criteria, BEQs were not retained as a surface soil COC for the industrial land use scenario. The nature of occurrence and the relevance of these COCs identified during the RFI at AOC 650 are further discussed below.

2.2.7.6.2.1 BEQs

BEQs were detected in 5 out of 10 surface soil samples at AOC 650, at concentrations ranging from 339.4 μg/kg to 3,075.2 μg/kg, as shown in Table 2-5. One of the detections, at a concentration of 3,075.2 μg/kg at location H650SB006, exceeded the surface soil CNC BEQ sitewide reference concentration of 1,304 μg/kg. The estimated exposure concentration for BEQs is 723 μg/kg (based on a UCL_{95} calculation), as shown in Appendix D. This value is below both the industrial RBC of 780 μg/kg for benzo(a)pyrene and the surface soil CNC BEQ sitewide reference concentration of 1,304 μg/kg. For this reason, BEQs are not considered a COC in surface soil at AOC 650 for the industrial land use scenario.

2.2.7.6.2.2 Aroclor 1254

Aroclor 1254 was detected in two out of nine surface soil samples, as shown in Table 2-5. The detections were at concentrations of 0.407 mg/kg and 0.051 mg/kg at locations H650SB002 and H650SB010, respectively, and did not exceed the industrial RBC of 2.9 mg/kg. For this reason, Aroclor 1254 is not considered a COC in surface soil at AOC 650 for the industrial land use scenario.

2.2.7.7 Soil COC Summary

BEQs at SWMU 121 are the only soil COC retained at Combined SWMU 9.

2.2.7.8 Combined SWMU 9 Groundwater

Based on the June 18, 1998 *Final RCRA Facility Investigation Report for Zone H* (EnSafe, 1998). the COCs contributing to the primary risk and hazard in the shallow and deep groundwater at Combined SWMU 9 are as follows:

Shallow Groundwater	Benzidine, Chlorinated Benzenes, Chlorinated Alkanes/Alkenes, Arsenic, Dioxins, Alkyphenols, Aromatics, and Antimony
Deep Groundwater	Thallium and Manganese

After the completion of the 1998 RFI, additional groundwater analytical samples were collected from the monitoring wells located within the footprint of SWMU 9 and select wells outside of SWMU 9. The select wells outside of SWMU 9 will be used as part of the monitoring network and are discussed in Section 5.0 of this CMS. Figure 2-11 shows the location of the sampled wells. To evaluate groundwater quality conditions at Combined SWMU 9, analytical results from each well were evaluated. Sampling results from wells associated with AOC 637 were also included as part of the Combined SWMU 9 groundwater evaluation. Results from earlier RFI sampling were rescreened in order to identify the specific shallow and deep groundwater COCs. The constituents detected above the maximum contaminant levels (MCLs), tap water RBCs, and Zone H background concentrations, when applicable, are further discussed in the following sections.

2.2.7.8.1 Volatile Organic Compounds

The VOCs detected above screening criteria are shown in Tables 2-5 and 2-6. The nature of occurrence and the relevance of these analytes is further discussed below.

2.2.7.8.1.1 1,1-Dichloroethene

1,1-Dichloroethene was detected in one well, H009GW007, at concentrations ranging from 3 micrograms per liter (µg/L) to 20 µg/L. Two of the detections at H009GW007, at concentrations of 8 µg/L and 20 µg/L, exceeded the MCL of 7 µg/L. During the four preceding groundwater monitoring events, 1,1-Dichloroethene was either not detected or detected below the MCL. However, 1,1-Dichloroethene is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.2 1,2-Dichloroethane

1,2-Dichloroethane was detected in one well, H009GW007, at concentrations ranging from 49 µg/L to 110 µg/L, which exceeded the MCL of 5 µg/L. For this reason 1,2-Dichloroethane is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.3 1,2-Dichloroethene (total)

1,2-Dichloroethene (total) was detected in three wells, at concentrations ranging from 0.8 µg/L to 3,500 µg/L. 1,2-Dichloroethene (total) consists of cis-1,2-dichloroethene, for which the MCL is 70 µg/L, and trans-1,2-dichloroethene, for which the MCL is 100 µg/L. Further, several detections exceeded the tap water RBC of 5.5 µg/L. For these reasons, 1,2-Dichloroethene (total) is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.4 Acetone

Acetone was detected in 17 wells at concentrations ranging from 2 µg/L to 230 µg/L. One of the detections, at a concentration of 230 µg/L at location H009GW010, exceeded the tap water RBC of 61 µg/L. An MCL for acetone is not available. The acetone exceedances at these three locations are preceded and followed by numerous acetone concentrations that are either below detection limits or the tap water RBC. In addition, acetone is a common laboratory contaminant. For these reasons, acetone is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.5 Benzene

Benzene was detected in 18 wells at concentrations ranging from 0.3 µg/L to 260 µg/L. Nine locations had detections that exceeded the MCL of 5 µg/L. For this reason, benzene is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.6 Chlorobenzene

Chlorobenzene detections exceeded the MCL of 100 µg/L in one well, H009GW010, at concentrations ranging from 140 µg/L to 1,300 µg/L. For this reason, chlorobenzene is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.7 Chloroethane

Chloroethane was detected in three wells, H009GW010, H009GW013, and H009GW024, at concentrations ranging from 6 µg/L to 17 µg/L. A chloroethane MCL does not exist. All of the detections exceeded that tap water RBC of 3.6 μg/L. However, at each location the most recent exceedance has been followed by concentrations that were below laboratory detection limits for at least two consecutive sampling events. For this reason, chloroethane is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.8 Chloroform

Chloroform was detected in two wells, H009GW007 and H009GW011, at concentrations ranging from 1 μg/L to 2 μg/L. None of these detections exceeded the MCL of 80 μg/L. For this reason, chloroform is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.9 Methylene Chloride

Methylene chloride was detected in nine wells, at concentrations ranging from 0.8 μg/L to 980 μg/L. Methylene chloride detections at four wells, ranging from 9 μg/L 980 μg/L, exceeded the MCL of 5 μg/L. The exceedances at all well locations, except H009GW007, are either preceded or followed by methylene chloride detections that are below either laboratory detection limits or the MCL. At location H009GW007, methylene chloride was detected above the MCL for all five sampling events. For this reason, methylene chloride is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.10 Trichloroethylene

Trichloroethylene was detected in three wells, at concentrations ranging from 0.3 μg/L to 360 μg/L. Eleven detections exceeded the MCL of 5 μg/L. For this reason, trichloroethylene is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.1.11 Vinyl chloride

Vinyl chloride was detected in six wells at concentrations ranging from 0.5 μg/L to 3,000 μg/L. Thirteen detections exceeded the MCL of 2 μg/L. For this reason, vinyl chloride is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2 Semivolatile Organic Compounds

The SVOCs detected in groundwater samples above the MCLs or Region III tap water RBCs at SWMU 9 are presented in Tables 2-6 and 2-7. The nature of occurrence and the relevance of these analytes is further discussed below.

2.2.7.8.2.1 2,4-Dimethylphenol

2,4-Dimethylphenol was detected in six wells. However, only one location, H009GW007, had detections that exceeded the tap water RBC of 73 μg/L. An MCL for 2,4-Dimethylphenol does not exist. Detections at H009GW007 ranged from 580 μg/L to

1,700 μg/L during four sampling events. For this reason, 2,4-Dimethylphenol is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2.2 2-Chlorophenol

2-Chlorophenol was detected in one well, H009GW010, at concentrations ranging from 3.3 μg/L to 15 μg/L. An MCL for 2-Chlorophenol does not exist. All five detections exceeded the tap water RBC of 3 μg/L. For this reason 2-Chlorophenol is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2.3 2-Methylnaphthalene

2-Methylnaphthalene was detected in 12 wells at concentrations ranging from 0.6 μg/L to 39 μg/L. An MCL for 2-Methylnaphthalene does not exist. Four detections at concentrations of 18 μg/L to 39 μg/L at location G637GW003 and at a concentration of 20 μg/L at location H009GW030 exceeded the tap water RBC of 12 μg/L. For this reason 2-Methylnaphthalene is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2.4 2-Methylphenol (o-Cresol)

2-Methylphenol (o-Cresol) exceeded the tap water RBC of 183 μg/L at location H009GW007, at concentrations of 270 μg/L and 390 μg/L. An MCL for 2-Methylphenol (o-Cresol) does not exist. Two of the four detections exceeded the tap water RBC. For this reason, 2-Methylphenol (o-Cresol) is considered a groundwater COC for Combined SWMU 9. 2-Methylphenol detections are presented in Table 2-7.

2.2.7.8.2.5 4-Methylphenol (p-Cresol)

4-Methylphenol (p-Cresol) exceeded the tap water RBC of 18 μg/L at locations G637GW003 and H009GW007, at concentrations ranging from 50 μg/L to 4,400 μg/L. An MCL for 4-Methylphenol (p-Cresol) does not exist. At location G637GW003, the exceedance was followed by detections that were below laboratory detection limits. At H009GW007, the detections exceeded the tap water RBC for all four sampling events. For these reasons, 4-Methylphenol (p-Cresol) is considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2.6 bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate exceeded the MCL of 6 μg/L at location H009GW03D, at a concentration of 25 μg/L. However, the exceedance was preceded and followed by concentrations that were below laboratory detection limits during the other sampling events. For this reason, bis(2ethylhexyl)phthalate is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2.7 Dibenzofuran

Dibenzofuran detections exceeded the tap water RBC of 2.4 μg/L during the four sampling events at location G637GW003, at concentrations ranging from 12 μg/L to 26 μg/L. An MCL for dibenzofuran does not exist. For this reason, dibenzofuran is considered a groundwater COC for Combined SWMU 9 Detections of dibenzofuran are presented in Table 2-7.

2.2.7.8.2.8 Fluorene

Fluorene exceeded the tap water RBC of 24 μg/L at location G637GW003, at concentrations of 27 μg/L and 28 μg/L during two sampling events. An MCL for fluorene does not exist. However, during the following two sampling events, the fluorene detections were below the tap water RBC. For this reason, fluorene is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.2.9 Naphthalene

Naphthalene was detected in 13 wells at SWMU 9. An MCL for naphthalene does not exist. Numerous detections, ranging from 1 μg/L to 240 μg/L, exceeded the tap water RBC of 0.65 μg/L. For this reason, naphthalene is considered a groundwater COC at SWMU 9.

2.2.7.8.2.10 Pentachlorophenol

Pentachlorophenol was detected in three wells, H009GW016, H009GW017, and H009GW018, at the concentration of 11 μg/L for all locations. These detections exceeded the MCL of 1 μg/L. However, these detections were followed by non-detects during subsequent sampling events. For this reason, pentachlorophenol is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.3 Pesticides, Herbicides, and PCBs

Based on the screening of historical and recent groundwater analytical results, no herbicides or PCBs were detected above laboratory detection limits. There were single detections of pesticides 4,4-DDT, 4,4-DDD, 4,4-DDE, alpha-chlordane, gamma-chlordane, beta-BHC, delta-BHC, gamma-BHC, Endosulfan I, Endosulfan II, heptachlor, heptachlor epoxide, as shown in Table 2-8. Among the detected pesticides, none exceeded their MCLs (or EPA Region III tap water RBCs for those chemicals with no MCLs established), indicating that they are not COCs. Based on these observations, pesticides are not considered COCs in groundwater at SWMU 9. Table 2.8 presents the pesticide detections.

2.2.7.8.4 Metals

Metals detected in groundwater samples above their respective MCLs or tap water RBCs and background concentrations at Combined SWMU 9 are presented in Tables 2-6 and 2-7.

The RFI report identified antimony and arsenic as shallow groundwater COCs and thallium and manganese as deep groundwater COCs for Combined SWMU 9. Evaluation of the RFI groundwater sampling data and additional sampling data collected from 1998 to 2002 showed that antimony, arsenic, barium, and lead were detected above their respective MCLs or shallow groundwater Zone H maximum background concentrations. Thallium and manganese were detected above their respective MCLs and deep groundwater Zone H maximum background concentrations.

However, based on further evaluation of the data, only barium and lead were retained as shallow groundwater COCs. No deep groundwater COCs were retained. The nature of occurrence and the relevance of these analytes is further discussed below.

2.2.7.8.4.1 Antimony

Antimony concentrations that exceeded the MCL of 6 μg/L were detected in four wells, at concentrations ranging from 9.1 μg/L to 45.6 μg/L, as shown in Table 2-6. At two of these wells, G637GW003 and H009GW016, antimony was not detected during subsequent groundwater sampling events. At H009GW024, antimony detections exceeded the MCL during the first two groundwater sampling events. However, these exceedances were succeeded by a detection below laboratory detection limits in the sample collected during January 2003. At G706GW001, antimony detections exceeded the MCL during the three most recent sampling events. For these reasons, antimony is considered a shallow groundwater COC for Combined SWMU 9.

2.2.7.8.4.2 Arsenic

Arsenic concentrations exceeded the MCL of 50 μg/L at three shallow well locations. At location GGDGGW001, detections exceeded the MCL during all five sampling events, at concentrations ranging from 79 μg/L to 166 μg/L. However, this is a grid well and was used to generate background concentrations for Zone G.

Only two other arsenic detections exceeded the MCL in shallow wells at Combined SWMU 9, with concentrations of 75 μg/L at H009GW008 and 56 μg/L at H009GW012, as shown in Table 2-6. However both of these exceedances are preceded and followed by arsenic concentrations either below the MCL or laboratory detection limits.

Arsenic was detected in deep groundwater at 54.6 μg/L at H009GW24D and at 74.8 μg/L at H009GW12D. The exceedance at H009GW12D was preceded and followed by consecutive concentrations that were either below the MCL or below laboratory detection limits during other sampling events. Although H009GW24D was sampled only once for arsenic, this well is located outside the footprint of SWMU 9 and no other wells showed consecutive arsenic detections above the background concentration. Therefore, this detection of arsenic is not considered to be related to site activities. For these reasons, arsenic is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.4.3 Barium

Barium concentrations exceeded the MCL and Zone H shallow groundwater maximum background concentration at three locations, G637GW003, G706GW001, and H009GW027, at concentrations ranging from 2,290 μg/L to 21,300 μg/L, as shown in Table 2-7. For this reason, barium is considered a shallow groundwater COC for Combined SWMU 9.

2.2.7.8.4.4 Lead

Lead concentrations exceeded the MCL at five shallow groundwater locations, G637GW001, H009GW001, H009GW009, H009GW016, and H009GW018, at concentrations ranging from 17.4 μg/L to 52.6 μg/L, as shown in Table 2-7. For this reason, lead is considered a shallow groundwater COC for Combined SWMU 9.

2.2.7.8.4.5 Manganese

Manganese concentrations exceeded the MCL of 50 μg/L and Zone H deep groundwater maximum background concentration of 821 μg/L at three deep groundwater locations, H009GW03D, H009GW07D, and H009GW24D, at concentrations ranging from 822 μg/L to 2,560 μg/L, as shown in Table 2-6. However, at locations, H009GW03D and H009GW07D, the exceedances were preceded or followed by detections that were below the Zone H deep groundwater maximum background concentration. Although H009GW24D was only sampled once for manganese, this well is located outside the footprint of SWMU 9 and no other wells showed manganese detections above the background concentration. Therefore, this detection of manganese is not considered to be related to site activities. For these reasons, manganese is not considered a groundwater COC for Combined SWMU 9.

2.2.7.8.4.6 Thallium

There were three thallium detections at locations H009GW02D, H009GW04D, and H009GW07D, that exceeded both the MCL and the Zone H deep groundwater maximum background concentration for thallium, as shown in Table 2-6. The detections ranged from 17.2 μg/L to 160 μg/L and were followed by concentrations that were below laboratory detection limits during the subsequent sampling events. Two of the detections were also preceded by concentrations that were below laboratory detection limits. Intermittent detections of thallium in shallow groundwater do not point to a site-specific source and can be attributed to natural occurrence. For these reasons, thallium is not considered a deep groundwater COC for Combined SMWU 9.

2.2.7.8.5 Dioxins

Dioxins were detected in six wells associated with SWMU 9. 2,3,7,8-TCDD equivalency quotients (TEQs) were calculated for these detections, as shown in Table 2-6. None of the TEQs exceeded the MCL 2,3,7,8-TCDD equivalent concentration of 30 picograms per liter (pg/L). For this reason, dioxins are not considered groundwater COCs for Combined SWMU 9.

2.2.7.9 Groundwater COC Summary

The contaminants that were identified as COCs in the shallow groundwater at Combined SWMU 9 are localized in nature. Wells with detections above the MCLs were bound by upgradient and downgradient wells with detections below detection limits (see Figures 2-12, 2-13, and 2-14). This indicates that the source of the impact is isolated and the contamination has stabilized and is not migrating.

There is one well location that had detections of analytes that exceed the COC screening criteria. Lead and naphthalene detections at H009GW001, barium detections at G706GW001, and chlorobenzene detections in H009GW013 exceed the screening criteria. H009GW001 is outside the footprint of the landfill.

The potential for deep groundwater impact at SWMU 9 is minimal due to the marsh clay that separates the upper (i.e., shallow groundwater) and lower (i.e., deep groundwater) silty sand units. Only manganese and thallium were detected above the MCLs in the deep groundwater at Combined SWMU 9. However, as discussed in Sections 2.2.7.8.4.5 and 2.2.7.8.4.6, these metals are not considered COCs for deep groundwater. Based on the most current analytical data available for each well, the following constituents were retained as groundwater COCs for Combined SWMU 9:

Shallow Groundwater	1,1-Dichloroethene, 1,2-Dichloroethane, 1,2-Dichloroethene (total), 2,4-Dimethylphenol, 2-Chlorophenol, 2-Methylnaphthalene, 2-Methylphenol (o-Cresol), 4-Methylphenol (p-Cresol), benzene, chlorobenzene, cis-1,2-Dichloroethylene, methylene chloride, naphthalene, trichloroethene (TCE), vinyl chloride, antimony, barium, and lead
Deep Groundwater	None

2.2.8 Summary of Baseline Risk Assessment

A BRA was performed for Combined SWMU 9 as part of the Zone H RFI (EnSafe, 1998). The HHRA conducted for individual SWMUs and AOCs located within SWMU 9 landfill footprint included the following exposure scenarios: 1) the hypothetical site worker, and 2) the hypothetical site resident (adult and child).

The exposure media evaluated included site soils and groundwater. Soil exposures were evaluated for ingestion and dermal contact. Groundwater exposures were evaluated for ingestion and inhalation from the shallow aquifer. No COCs were found in the deeper surficial aquifer.

The containment presumptive remedy is considered as the remedy for Combined SWMU 9 (see Section 4.0). As such, the subsurface contamination will be managed under a containment remedy component, with the implementation of the land use controls (LUCs) and long-term monitoring (LTM) components to ensure the integrity and effectiveness of the containment measure. Therefore, only surface soil and groundwater media were evaluated for potential exposure risks.

The exposure risk calculation was based on a sitewide statistical averages (e.g., UCL_{95} - parametric and non-parametric) for carcinogenic and noncarcinogenic COPCs. The COPCs identified for surface soil were below industrial RBCs, facility-wide background concentrations, or the calculated UCL_{95} values for the industrial exposure scenario. Therefore, none of the COPCs identified for surface soil present excessive risks or hazards above acceptable levels for the industrial exposure scenario. These COPCs are not considered to pose a risk at the site that requires remediation, as long as the site continues under a restricted exposure (use) scenario.

Several COPCs identified for shallow and deep groundwater were found above the initial screening criteria (see Section 2.2.7) and were identified as COCs for further evaluation. Many of the groundwater samples exhibiting the presence of contaminants above the screening criteria are located within the footprint of the landfill or located upgradient of Combined SWMU 9. In addition, the containment presumptive remedy is considered as the remedy for Combined SWMU 9 (see Section 4.0). On the basis of these factors, corrective measure objectives were developed for the analytes considered as COCs for the groundwater at Combined SWMU 9 (see Section 3.0).

Ecological protection criteria for surface water were considered (derived from the Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995). These are screening values protective of aquatic organisms; a separate set of values are provided for freshwater and salt water organisms. There are two sets of criteria: 1) chronic (long-term exposures), and 2) acute (short-term exposures) screening values. The chronic (more conservative of the two) values will be used as the target criteria for the surface water bodies.

However, surface water monitoring conducted during the SWMU 9 RFI did not indicate detectable levels of constituents or the detected concentrations were below ecological protection criteria. Therefore, based on the RFI information, no ecological impacts from Combined SWMU 9 were found at the site.

TABLE 2-1
Detected Concentrations of BEQs, Aroclor 1254, Aroclor 1260, Arsenic, Beryllium, Copper, Nickel, and Zinc in Surface Soil at SWMU 19
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
BEQs [a]	Surface Soil		(µg/kg)			780	NA	1,304	1,304
	H019SB001	019SB00101	356.76	=	08/27/1994				
	H019SB002	019SB00201	913.32	=	08/27/1994				
	H019SB003	019SB00301	519.84	=	08/29/1994				
	H019SB004	019SB00401	419.00	=	08/29/1994				
	H019SB005	019SB00501	542.88	=	01/17/1995				
	H019SB006	019SB00601	849.92	=	01/17/1995				
	H019SB007	019SB00701	431.55	=	01/17/1995				
	H019SB008	019SB00801	485.20	=	01/17/1995				
	H019SB009	019SB00901	417.59	=	01/17/1995				
	H019SB010	019SB01001	1,059.69	=	01/17/1995				
	H019SB012	019SB01201	554.64	U	01/17/1995				
	H019SB013	019SB01301	450.65	U	01/17/1995				
	H019SB014	019SB01401	310.15	=	01/16/1995				
	H019SB016	019SB01601	450.65	U	03/22/1995				
	H019SB017	019SB01701	483.83	=	03/22/1995				
	H019SB018	019SB01801	795.35	=	03/22/1995				
Aroclor 1254	Surface Soil		(mg/kg)			2.9	1	NA	NA
	H019SB001	019SB00101	0.040	U	08/27/1994				
	H019SB002	019SB00201	0.040	U	08/27/1994				
	H019SB003	019SB00301	0.040	U	08/29/1994				
	H019SB004	019SB00401	0.040	U	08/29/1994				
	H019SB005	019SB00501	0.040	U	01/17/1995				
	H019SB006	019SB00601	0.040	U	01/17/1995				
	H019SB007	019SB00701	2.300	=	01/17/1995				
	H019SB008	019SB00801	0.040	U	01/17/1995				
	H019SB009	019SB00901	0.050	U	01/17/1995				
	H019SB010	019SB01001	0.040	U	01/17/1995				
	H019SB011	019SB01101	0.040	U	01/17/1995				
	H019SB012	019SB01201	0.050	U	01/17/1995				
	H019SB013	019SB01301	0.040	U	01/17/1995				
	H019SB014	019SB01401	0.040	U	01/16/1995				
	H019SB016	019SB01601	0.040	U	03/22/1995				
	H019SB017	019SB01701	0.040	U	03/22/1995				
	H019SB018	019SB01801	0.040	U	03/22/1995				

TABLE 2-1
Detected Concentrations of BEQs, Aroclor 1254, Aroclor 1260, Arsenic, Beryllium, Copper, Nickel, and Zinc in Surface Soil at SWMU 19
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
Aroclor 1260	Surface Soil		(mg/kg)			2.9	1	NA	NA
	H019SB001	019SB00101	0.040	U	08/27/1994				
	H019SB002	019SB00201	0.040	U	08/27/1994				
	H019SB003	019SB00301	0.040	U	08/29/1994				
	H019SB004	019SB00401	0.400	=	08/29/1994				
	H019SB005	019SB00501	0.110	J	01/17/1995				
	H019SB006	019SB00601	0.190	J	01/17/1995				
	H019SB007	019SB00701	0.560	=	01/17/1995				
	H019SB008	019SB00801	0.032	J	01/17/1995				
	H019SB009	019SB00901	0.130	J	01/17/1995				
	H019SB010	019SB01001	0.068	=	01/17/1995				
	H019SB011	019SB01101	0.180	=	01/17/1995				
	H019SB012	019SB01201	0.050	U	01/17/1995				
	H019SB013	019SB01301	0.040	UJ	01/17/1995				
	H019SB014	019SB01401	0.037	J	01/16/1995				
	H019SB016	019SB01601	0.040	U	03/22/1995				
	H019SB017	019SB01701	0.092	=	03/22/1995				
	H019SB018	019SB01801	0.370	=	03/22/1995				
Arsenic	Surface Soil		(mg/kg)			3.8	14.5	18	25
	H019SB001	019SB00101	16.5	=	08/27/1994				
	H019SB002	019SB00201	13.4	=	08/27/1994				
	H019SB003	019SB00301	21.4	=	08/29/1994				
	H019SB004	019SB00401	4.7	=	08/29/1994				
	H019SB005	019SB00501	8.8	=	01/17/1995				
	H019SB006	019SB00601	5.4	J	01/17/1995				
	H019SB007	019SB00701	4.1	J	01/17/1995				
	H019SB008	019SB00801	10.7	=	01/17/1995				
	H019SB009	019SB00901	22.1	=	01/17/1995				
	H019SB010	019SB01001	8.2	=	01/17/1995				
	H019SB011	019SB01101	3.8	=	01/17/1995				
	H019SB012	019SB01201	10.9	=	01/17/1995				
	H019SB013	019SB01301	3.0	J	01/17/1995				
	H019SB014	019SB01401	5.7	J	01/16/1995				
	H019SB016	019SB01601	2.0	U	03/22/1995				
	H019SB017	019SB01701	8.2	U	03/22/1995				
	H019SB018	019SB01801	2.6	U	03/22/1995				

TABLE 2-1
Detected Concentrations of BEQs, Aroclor 1254, Aroclor 1260, Arsenic, Beryllium, Copper, Nickel, and Zinc in Surface Soil at SWMU 19
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
Beryllium	**Surface Soil**		**(mg/kg)**			410	31.5	1.4	1.1
	H019SB001	019SB00101	0.3	J	08/27/1994				
	H019SB002	019SB00201	0.5	=	08/27/1994				
	H019SB003	019SB00301	0.4	J	08/29/1994				
	H019SB004	019SB00401	3.0	=	08/29/1994				
	H019SB005	019SB00501	0.6	=	01/17/1995				
	H019SB006	019SB00601	0.7	=	01/17/1995				
	H019SB007	019SB00701	1.2	=	01/17/1995				
	H019SB008	019SB00801	1.0	=	01/17/1995				
	H019SB009	019SB00901	0.8	=	01/17/1995				
	H019SB010	019SB01001	0.4	U	01/17/1995				
	H019SB011	019SB01101	0.8	=	01/17/1995				
	H019SB012	019SB01201	0.3	U	01/17/1995				
	H019SB013	019SB01301	0.15	J	01/17/1995				
	H019SB014	019SB01401	0.7	=	01/16/1995				
	H019SB016	019SB01601	0.15	J	03/22/1995				
	H019SB017	019SB01701	0.5	J	03/22/1995				
	H019SB018	019SB01801	0.7	=	03/22/1995				
Copper	**Surface Soil**		**(mg/kg)**			8,200	NA	126	431
	H019SB001	019SB00101	169.0	=	08/27/1994				
	H019SB002	019SB00201	310.0	=	08/27/1994				
	H019SB003	019SB00301	241.0	=	08/29/1994				
	H019SB004	019SB00401	1,730.0	=	08/29/1994				
	H019SB005	019SB00501	609.0	=	01/17/1995				
	H019SB006	019SB00601	699.0	=	01/17/1995				
	H019SB007	019SB00701	3,040.0	=	01/17/1995				
	H019SB008	019SB00801	286.0	=	01/17/1995				
	H019SB009	019SB00901	427.0	=	01/17/1995				
	H019SB010	019SB01001	426.0	=	01/17/1995				
	H019SB011	019SB01101	1,120.0	=	01/17/1995				
	H019SB012	019SB01201	11.6	UJ	01/17/1995				
	H019SB013	019SB01301	5.9	J	01/17/1995				
	H019SB014	019SB01401	1,360.0	=	01/16/1995				
	H019SB016	019SB01601	6.6	UJ	03/22/1995				
	H019SB017	019SB01701	130.0	J	03/22/1995				
	H019SB018	019SB01801	562.0	J	03/22/1995				

TABLE 2-1
Detected Concentrations of BEQs, Aroclor 1254, Aroclor 1260, Arsenic, Beryllium, Copper, Nickel, and Zinc in Surface Soil at SWMU 19
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
Nickel	**Surface Soil**		**(mg/kg)**			4,100	65	92	27
	H019SB001	019SB00101	12.7	=	08/27/1994				
	H019SB002	019SB00201	25.1	=	08/27/1994				
	H019SB003	019SB00301	23.1	=	08/29/1994				
	H019SB004	019SB00401	282.0	=	08/29/1994				
	H019SB005	019SB00501	52.4	=	01/17/1995				
	H019SB006	019SB00601	51.4	=	01/17/1995				
	H019SB007	019SB00701	23.2	J	01/17/1995				
	H019SB008	019SB00801	28.5	=	01/17/1995				
	H019SB009	019SB00901	31.4	=	01/17/1995				
	H019SB010	019SB01001	56.4	=	01/17/1995				
	H019SB011	019SB01101	136.0	=	01/17/1995				
	H019SB012	019SB01201	3.9	UJ	01/17/1995				
	H019SB013	019SB01301	2.7	UJ	01/17/1995				
	H019SB014	019SB01401	73.7	=	01/16/1995				
	H019SB016	019SB01601	2.7	J	03/22/1995				
	H019SB017	019SB01701	18.0	J	03/22/1995				
	H019SB018	019SB01801	99.9	J	03/22/1995				
Zinc	**Surface Soil**		**(mg/kg)**			61,000	6,000	431	1,650
	H019SB002	019SB00201	423.0	=	08/27/1994				
	H019SB003	019SB00301	150.0	=	08/29/1994				
	H019SB004	019SB00401	2,800.0	=	08/29/1994				
	H019SB005	019SB00501	503.0	=	01/17/1995				
	H019SB006	019SB00601	684.0	=	01/17/1995				
	H019SB007	019SB00701	478.0	=	01/17/1995				
	H019SB008	019SB00801	393.0	=	01/17/1995				
	H019SB009	019SB00901	427.0	=	01/17/1995				
	H019SB010	019SB01001	246.0	=	01/17/1995				
	H019SB011	019SB01101	1,230.0	=	01/17/1995				
	H019SB012	019SB01201	11.9	U	01/17/1995				
	H019SB013	019SB01301	12.3	=	01/17/1995				
	H019SB014	019SB01401	689.0	=	01/16/1995				
	H019SB016	019SB01601	16.2	=	03/22/1995				
	H019SB017	019SB01701	354.0	=	03/22/1995				
	H019SB018	019SB01801	762.0	=	03/22/1995				

[a] BEQ calculation method based on background polycyclic aromatic hydrocarbons (PAHs) study report, technical information for development of background BEQ values (CH2M-Jones, 2001).
Note: Concentrations in bold and outlined text exceed the appropriate screening criteria.

J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.
U Indicates that the concentration was not detected.
ssl soil screening level

TABLE 2-2

Detected Concentrations of BEQs in Surface Soil at SWMU 20

CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/kg)	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
BEQs [a]	**Surface Soil**					780	NA	1,304	1,304
	H009SB071	009SB07101	7.07	=	09/29/1993				
	H020SB001	020SB00101	494.85	=	03/27/1995				
	H020SB002	020SB00201	428.02	=	03/27/1995				
	H020SB003	020SB00301	446.95	=	03/27/1995				
	H020SB004	020SB00401	316.71	=	03/27/1995				
	H020SB005	020SB00501	1,268.34	=	03/27/1995				
	H020SB006	020SB00601	458.34	=	03/27/1995				
	H020SB007	020SB00701	399.76	=	03/27/1995				
	H020SB008	020SB00801	830.16	=	03/27/1995				
	H020SB009	020SB00901	795.60	=	03/28/1995				
	H020SB010	020SB01001	391.99	=	03/28/1995				
	H020SB011	020SB01101	1,502.15	U	03/28/1995				

[a] BEQ calculation method based on background PAHs study report, technical information for development of background BEQ values (CH2M-Jones, 2001).

Note: Concentrations in bold and outlined text exceed the appropriate screening criteria.

U Indicates that the concentration was not detected.

TABLE 2-3

Detected Concentrations of BEQs, Arsenic, Beryllium, and Aroclor 1254 in Surface Soil at SWMU 121
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
BEQs [a]	**Surface Soil**		**(μg/kg)**			780	NA	1,304	1,304
	H121SB001	121SB00101	415.98	U	08/26/1994				
	H121SB002	121SB00201	330.71	=	08/26/1994				
	H121SB003	121SB00301	485.31	U	08/26/1994				
	H121SB004	121SB00401	316.30	=	08/26/1994				
	H121SB005	121SB00501	1,848.80	U	08/26/1994				
	H121SB006	121SB00601	477.31	=	01/16/1995				
	H121SB007	121SB00701	359.04	=	01/13/1995				
	H121SB008	121SB00801	496.87	U	01/16/1995				
	H121SB009	121SB00901	812.66	=	01/16/1995				
	H121SB010	121SB01001	929.85	=	01/16/1995				
	H121SB011	121SB01101	2,524.90	=	01/16/1995				
	H121SB013	121SB01301	2,106.70	=	03/22/1995				
	H121SB014	121SB01401	371.01	=	03/22/1995				
	H121SB015	121SB01501	530.99	=	03/22/1995				
	H121SB016	121SB01601	907.63	=	03/22/1995				
	H121SB017	121SB01701	485.31	U	03/22/1995				
Arsenic	**Surface Soil**		**(mg/kg)**			3.8	14.5	18	25
	H121SB001	121SB00101	3.5	J	08/26/1994				
	H121SB002	121SB00201	5.2	=	08/26/1994				
	H121SB003	121SB00301	12.0	=	08/26/1994				
	H121SB004	121SB00401	18.7	=	08/26/1994				
	H121SB005	121SB00501	5.4	=	08/26/1994				
	H121SB006	121SB00601	9.0	=	01/16/1995				
	H121SB007	121SB00701	6.2	=	01/13/1995				
	H121SB008	121SB00801	10.7	=	01/16/1995				
	H121SB009	121SB00901	8.0	=	01/16/1995				
	H121SB010	121SB01001	7.4	J	01/16/1995				
	H121SB011	121SB01101	8.8	=	01/16/1995				
	H121SB013	121SB01301	9.9	U	03/22/1995				
	H121SB014	121SB01401	5.4	U	03/22/1995				
	H121SB015	121SB01501	1.6	U	03/22/1995				
	H121SB016	121SB01601	13.5	U	03/22/1995				
	H121SB017	121SB01701	2.4	U	03/22/1995				

TABLE 2-3

Detected Concentrations of BEQs, Arsenic, Beryllium, and Aroclor 1254 in Surface Soil at SWMU 121

CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
Beryllium	**Surface Soil**		**(mg/kg)**			410	31.5	1.4	1.1
	H121SB001	121SB00101	0.5	J	08/26/1994				
	H121SB002	121SB00201	0.7	=	08/26/1994				
	H121SB003	121SB00301	1.7	=	08/26/1994				
	H121SB004	121SB00401	4.8	=	08/26/1994				
	H121SB005	121SB00501	0.8	J	08/26/1994				
	H121SB006	121SB00601	4.7	=	01/16/1995				
	H121SB007	121SB00701	14.6	=	01/13/1995				
	H121SB008	121SB00801	0.9	=	01/16/1995				
	H121SB009	121SB00901	3.2	=	01/16/1995				
	H121SB010	121SB01001	1.7	J	01/16/1995				
	H121SB011	121SB01101	2.0	=	01/16/1995				
	H121SB013	121SB01301	0.8	=	03/22/1995				
	H121SB014	121SB01401	4.1	=	03/22/1995				
	H121SB015	121SB01501	1.4	=	03/22/1995				
	H121SB016	121SB01601	4.6	=	03/22/1995				
	H121SB017	121SB01701	0.16	J	03/22/1995				
Aroclor 1254	**Surface Soil**		**(mg/kg)**			2.9	1	NA	NA
	H121SB001	121SB00101	0.040	U	08/26/1994				
	H121SB002	121SB00201	0.040	UJ	08/26/1994				
	H121SB003	121SB00301	0.040	U	08/26/1994				
	H121SB004	121SB00401	0.040	U	08/26/1994				
	H121SB005	121SB00501	0.040	U	08/26/1994				
	H121SB006	121SB00601	0.140	=	01/16/1995				
	H121SB007	121SB00701	0.210	=	01/13/1995				
	H121SB008	121SB00801	0.040	U	01/16/1995				
	H121SB009	121SB00901	0.240	=	01/16/1995				
	H121SB010	121SB01001	0.350	=	01/16/1995				
	H121SB011	121SB01101	0.320	=	01/16/1995				
	H121SB013	121SB01301	0.040	U	03/22/1995				
	H121SB014	121SB01401	0.040	U	03/22/1995				
	H121SB015	121SB01501	0.040	U	03/22/1995				
	H121SB016	121SB01601	**4.30**	=	03/22/1995				
	H121SB017	121SB01701	0.040	U	03/22/1995				

[a] BEQ calculation method based on background PAHs study report, technical information for development of background BEQ values (CH2M-Jones, 2001).

Note: Concentrations in bold and outlined text exceed the appropriate screening criteria.

J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.

U Indicates that the concentration was not detected.

TABLE 2-4
Detected Concentrations of Arsenic, Thallium, BEQs, and Hydrazine in Soil at AOC 637
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone G Background Range of Conc.	Zone H Background Range of Conc.
Arsenic	**Surface Soil**		**(mg/kg)**			**3.8**	**2.5**	**3.1 – 25**	**0.64– 18**
	G637SB001	637SB00101	**7.3**	=	09/13/1996				
	G637SB006	637SB00601	**6.0**	=	01/07/1997				
	G637SB007	637SB00701	**24.4**	J	01/07/1997				
	G637SB005	637SB00501	**9.8**	=	09/13/1996				
	G637SB003	637SB00301	**6.8**	=	09/13/1996				
	G637SB004	637SB00401	**4.2**	=	09/13/1996				
	G637SB002	637SB00201	**6.9**	=	09/13/1996				
	Subsurface Soil		**(mg/kg)**			**3.8**	**2.5**	**1.4 – 36**	**0.78 – 136**
	G637SB003	637SB00302	**5.90**	=	09/13/1996				
	G637SB006	637SB00602	**7.50**	=	01/07/1997				
Thallium	**Surface Soil**		**(mg/kg)**			**14**	**0.35**	**0.55 – 0.91**	**0.12–1.1**
	G637SB001	637SB00101	0.37	U	09/13/1996				
	G637SB006	637SB00601	0.38	U	01/07/1997				
	G637SB007	637SB00701	1.20	J	01/07/1997				
	G637SB005	637SB00501	0.48	U	09/13/1996				
	G637SB003	637SB00301	0.37	U	09/13/1996				
	G637SB004	637SB00401	0.38	U	09/13/1996				
	G637SB002	637SB00201	0.82	J	09/13/1996				
	Subsurface Soil		**(mg/kg)**			**14**	**0.35**	**1 – 1**	**0.36–1.9**
	G637SB003	637SB00302	0.64	J	09/13/1996				
	G637SB006	637SB00602	0.65	J	01/07/1997				
BEQs [a]	**Surface Soil**		**(µg/kg)**			**780**	**NA**	**1,304**	**1,304**
	G637SB001	637SB00101	21.6	=	09/13/1996				
	G637SB002	637SB00102	6.4	=	09/13/1996				
	G637SB003	637SB00103	15.1	=	09/13/1996				
	G637SB004	637SB00104	6.1	U	09/13/1996				
	G637SB005	637SB00105	7.6	U	09/13/1996				
	G637SB006	637SB00106	12.6	=	09/13/1996				
	G637SB007	637SB00107	12.4	=	09/13/1996				
	Subsurface Soil		**(µg/kg)**			**780**	**NA**	**1,400**	**1,400**
	G637SB003	637SB00302	30.5	U	09/13/1996				
	G637SB006	637SB00602	94	=	01/07/1997				
Hydrazine	**Surface Soil**		**(mg/kg)**			**1.9**	**NA**	**NA**	**NA**
	G637SB001	637SB00101	0.171	=	09/13/1996				
	G637SB004	637SB00401	0.120	=	09/13/1996				
	G637SB003	637SB00301	0.213	=	09/13/1996				
	G637SB002	637SB00201	0.129	=	09/13/1996				
	G637SB005	637SB00501	0.118	J	09/13/1996				

TABLE 2-4
Detected Concentrations of Arsenic, Thallium, BEQs, and Hydrazine in Soil at AOC 637
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone G Background Range of Conc.	Zone H Background Range of Conc.
	Subsurface Soil		**(mg/kg)**			**1.9**	**NA**	**NA**	
	G637SB003	637SB00302	0.323	=	09/13/1996				

[A] BEQ calculation method based on background PAHs study report, technical information for development of background BEQ values (CH2M-Jones, February 2001).
Notes:
Concentrations in bold and outlined text exceed the appropriate screening criteria.
Average concentrations were calculated by using the full value of the detected concentrations and half the detection limit for sample results with U or UJ qualifiers.

TABLE 2-5
Detected Concentrations of BEQs and Aroclor 1254 in Surface Soil at AOCs 649, 650 and 651
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result	Qualifier	Date Collected	Region III Industrial RBC	SSL	Zone H Max. Background Conc.	Zone G Max. Background Conc.
BEQs[a]	**Surface Soil**		**(µg/kg)**			780	NA	1,304	1,304
	H649SB001	649SB00101	313.69	=	08/22/1994				
	H649SB002	649SB00201	345.89	=	08/22/1994				
	H649SB003	649SB00301	485.31	U	08/22/1994				
	H649SB004	649SB00401	404.92	=	08/22/1994				
	H649SB005	649SB00501	531.36	=	08/22/1994				
	H649SB006	649SB00601	508.42	U	01/19/1995				
	H649SB007	649SB00701	496.87	U	01/19/1995				
	H649SB008	649SB00801	519.98	U	01/19/1995				
	H649SB009	649SB00901	508.42	U	01/19/1995				
	H649SB010	649SB01001	395.98	=	01/19/1995				
	H650SB001	650SB00101	359.30	=	08/22/1994				
	H650SB002	650SB00201	339.40	=	08/22/1994				
	H650SB003	650SB00301	485.31	U	08/22/1994				
	H650SB004	650SB00401	1,175.76	=	08/22/1994				
	H650SB005	650SB00501	519.98	U	01/19/1995				
	H650SB006	650SB00601	**3,075.15**	=	01/19/1995				
	H650SB007	650SB00701	496.87	U	01/19/1995				
	H650SB009	650SB00901	496.01	=	01/19/1995				
	H650SB010	650SB01001	462.20	U	01/19/1995				
	H650SB010	650SB01002	473.76	U	01/19/1995				
Aroclor-1254	**Surface Soil**		**(mg/kg)**			2.9	1	NA	NA
	H650SB001	650SB00101	0.073	U	08/22/1994				
	H650SB002	650SB00201	0.407	=	08/22/1994				
	H650SB003	650SB00301	0.076	U	08/22/1994				
	H650SB004	650SB00401	0.073	U	08/22/1994				
	H650SB005	650SB00501	0.040	U	01/19/1995				
	H650SB006	650SB00601	0.040	U	01/19/1995				
	H650SB007	650SB00701	0.040	U	01/19/1995				
	H650SB009	650SB00901	0.040	U	01/19/1995				
	H650SB010	650SB01001	0.051	=	01/19/1995				

[a] BEQ calculation method based on background PAHs study report, technical information for development of background BEQ values (CH2M-Jones, 2001).
Note: Concentrations in bold and outlined text exceed the appropriate screening criteria.
NA Not applicable
U Indicates that the concentration was not detected.

TABLE 2-6
Groundwater COPCs Not Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (μg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Acetone	H009GW010	009GW01001	210	U	11/07/1994	NA	61	NA	NA	NA	NA
	H009GW010	009GW01002	230	J	04/25/1995						
	H009GW010	009GW01003	250	U	09/29/1995						
	H009GW010	009GW01004	10	U	04/10/1996						
	H009GW010	009GW01001a	5	SU	03/11/1998						
	H009GW010	009GW01002a	5	SU	09/28/1998						
	H009GW010	009G001010	40	U	07/19/2000						
Chloroethane	H009GW010	009GW01001	42	U	11/07/1994	NA	3.6	NA	NA	NA	NA
	H009GW010	009GW01002	25	U	04/25/1995						
	H009GW010	009GW01003	50	U	09/29/1995						
	H009GW010	009GW01004	10	U	04/10/1996						
	H009GW010	009GW01001a	8	S=	03/11/1998						
	H009GW010	009GW01002a	5	SU	09/28/1998						
	H009GW010	009G001010	40	U	07/19/2000						
	H009GW013	009GW01301	7	=	11/18/1994						
	H009GW013	009GW01302	6	=	04/17/1995						
	H009GW013	009GW01303	5	U	10/02/1995						
	H009GW013	009GW01304	10	U	04/12/1996						
	H009GW013	009GW01302a	5	SU	09/28/1998						
	H009GW013	009GW013C1	5	U	10/20/1999						
	H009GW013	009G001310	10	U	07/19/2000						
	H009GW024	009GW02401	17	=	08/10/1998						
	H009GW024	009GW02402	5	SU	10/07/1998						
	H009GW024	009GW024C1	5	U	10/19/1999						
	H009GW024	009G002410	10	U	07/19/2000						

TABLE 2-6
Groundwater COPCs Not Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Chloroform	H009GW007	009GW00701	25	U	11/10/1994	80	0.15	NA	NA	NA	NA
	H009GW007	009GW00702	13	U	04/24/1995						
	H009GW007	009GW00703	17	U	09/14/1995						
	H009GW007	009GW00704	5	U	03/20/1996						
	H009GW007	009GW00701a	2	SJ	03/11/1998						
	H009GW007	009GW00702a	5	SU	09/27/1998						
	H009GW011	009GW01101	5	U	11/05/1994						
	H009GW011	009GW01102a	5	U	04/14/1995						
	H009GW011	009GW01103	5	U	09/28/1995						
	H009GW011	009GW01104	5	U	04/10/1996						
	H009GW011	009GW01101a	1	SJ	03/16/1998						
	H009GW011	009GW01102	5	SU	09/28/1998						
	H009GW011	009G001110	5	U	07/19/2000						
bis(2-ethylhexyl)phthalate	H009GW03D	009GW03D01	10	U	11/19/1994	6	NA	NA	NA	NA	NA
	H009GW03D	009GW03D02	12	U	04/19/1995						
	H009GW03D	009GW03D03	25	=	09/26/1995						
	H009GW03D	009GW03D04	10	U	04/04/1996						
Fluorene	G637GW003	637GW003A1	28	J	04/30/1997	NA	24	NA	NA	NA	NA
	G637GW003	637GW003A2	27	=	09/14/1997						
	G637GW003	637GW003A3	16	J	12/10/1997						
	G637GW003	637GW003A4	16	=	02/12/1998						
Pentachlorophenol	H009GW016	009GW01601	11	J	04/19/1995	1	NA	NA	NA	NA	NA
	H009GW016	009GW01603a	10	U	09/15/1995						
	H009GW016	009GW01604	50	U	03/21/1996						

TABLE 2-6
Groundwater COPCs Not Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (μg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
	H009GW017	009GW01701	**11**	J	04/19/1995						
	H009GW017	009GW01703	11	U	10/11/1995						
	H009GW017	009GW01704	50	U	04/16/1996						
	H009GW018	009GW01801	**11**	J	04/20/1995						
	H009GW018	009GW01804b	50	U	04/18/1996						
Arsenic	H009GW008	009GW00801	40.4	U	11/28/1994	50	0.045	50	8	166	58
	H009GW008	009GW00802	**75**	=	04/25/1995						
	H009GW008	009GW00803	36.0	U	09/28/1995						
	H009GW008	009GW00804	12.1	U	04/08/1996						
	H009GW012	009GW01201	55.8	U	11/22/1994						
	H009GW012	009GW01202	22.6	=	04/24/1995						
	H009GW012	009GW01203	**56**	=	09/29/1995						
	H009GW012	009GW01204	38.5	=	04/11/1996						
	H009GW12D	009GW12D01	2.3	J	11/18/1994						
	H009GW12D	009GW12D02	2.7	U	04/24/1995						
	H009GW12D	009GW12D03	**74.8**	=	09/29/1995						
	H009GW12D	009GW12D03a	1.5	U	09/29/1995						
	H009GW12D	009GW12D04	2.5	U	04/11/1996						
	H009GW24D	009GW24D01	**54.6**	J	08/10/1998						
	GGDGGW001	GDGGW00101	**117**	=	11/16/1996						
	GGDGGW001	GDGGW001A1	**126**	=	01/29/1997						
	GGDGGW001	GDGGW00102	**166**	=	06/18/1997						
	GGDGGW001	GDGGW00103	**112**	=	09/17/1997						
	GGDGGW001	GDGGW00104	**79.9**	=	12/16/1997						

TABLE 2-6
Groundwater COPCs Not Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Manganese	H009GW03D	009GW03D01	805	=	11/19/1994	50	73	4,570	821	7,980	9,030
	H009GW03D	009GW03D02	**1,220**	=	04/19/1995						
	H009GW03D	009GW03D03	**910**	J	09/26/1995						
	H009GW03D	009GW03D04	766	=	04/04/1996						
	H009GW07D	009GW07D01	755	=	11/10/1994						
	H009GW07D	009GW07D02	**1,270**	=	04/24/1995						
	H009GW07D	009GW07D03	822	=	09/15/1995						
	H009GW07D	009GW07D04	809	J	03/21/1996						
	H009GW24D	009GW24D01	**2,560**	J	08/10/1998						
Thallium	H009GW02D	009GW02D01	5.8	UJ	11/02/1994	2	0.26	105	6	NA	NA
	H009GW02D	009GW02D02	3.3	U	04/17/1995						
	H009GW02D	009GW02D03	**17.3**	J	09/14/1995						
	H009GW02D	009GW02D04	2.7	UJ	03/19/1996						
	H009GW04D	009GW04D01	**160**	J	11/21/1994						
	H009GW04D	009GW04D02	3.3	U	04/19/1995						
	H009GW04D	009GW04D03	12.5	U	09/27/1995						
	H009GW04D	009GW04D04	2.7	UJ	04/05/1996						
	H009GW07D	009GW07D01	10.0	U	11/10/1994						
	H009GW07D	009GW07D02	3.3	U	04/24/1995						
	H009GW07D	009GW07D03	**17.2**	J	09/15/1995						
	H009GW07D	009GW07D04	2.9	UJ	03/21/1996						

TABLE 2-6
Groundwater COPCs Not Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
TEQs			(pg/kg)								
	H009GW001	009GW001C1	12	U	10/19/1999	30	NA	NA	NA	NA	NA
	H009GW002	009GW00203	1	=	09/14/1995						
	H009GW002	009GW00204	3	U	03/19/1996						
	H009GW004	009GW004C1	11	U	10/19/1999						
	H009GW005	009GW00504	3	=	04/10/1996						
	H009GW007	009GW00703	2	=	09/14/1995						
	H009GW007	009GW00704	1	=	03/20/1996						
	H009GW008	009GW008C1	10	U	10/19/1999						
	H009GW013	009GW013C1	2	=	10/20/1999						
	H009GW016	009GW01603b	2	=	09/19/1995						
	H009GW016	009GW01604	4	=	03/21/1996						
	H009GW024	009GW024C1	8	=	10/19/1999						

Note: Concentrations in bold and outlined text exceed the appropriate screening criteria.
J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.
U Indicates that the concentration was not detected.
S Indicates that the data has not been validated and can only be used for screening.
NA Screening criteria not available for the referenced compound.

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
1,1-Dichloroethene	H009GW007	009GW00701	25.0	U	11/10/1994	7	NA	NA	NA	NA	NA
	H009GW007	009GW00702	13.0	U	04/24/1995						
	H009GW007	009GW00703	17.0	U	09/14/1995						
	H009GW007	009GW00704	3.0	J	03/20/1996						
	H009GW007	009GW00701a	**20.0**	S=	03/11/1998						
	H009GW007	009GW00702a	**8.0**	S=	09/27/1998						
1,2-Dichloroethane	H009GW007	009GW00701	**59**	=	11/10/1994	5	NA	NA	NA	NA	NA
	H009GW007	009GW00702	**56**	=	04/24/1995						
	H009GW007	009GW00703	**49**	=	09/14/1995						
	H009GW007	009GW00704	**50**	=	03/20/1996						
	H009GW007	009GW00701a	**110**	S=	03/11/1998						
	H009GW007	009GW00702a	**96**	S=	09/27/1998						
1,2-Dichloroethene (total)	H009GW007	009GW00701	**86**	=	11/10/1994	NA	5.5	NA	NA	NA	NA
	H009GW007	009GW00702	**160**	=	04/24/1995						
	H009GW007	009GW00703	**130**	=	09/14/1995						
	H009GW007	009GW00704	**360**	=	03/20/1996						
	H009GW007	009GW00701a	**3,500**	SJ	03/11/1998						
Dibenzofuran	G637GW003	637GW003A1	**26**	J	04/30/1997	NA	2.4	NA	NA	NA	NA
	G637GW003	637GW003A2	**24**	=	09/14/1997						
	G637GW003	637GW003A3	**12**	J	12/10/1997						
	G637GW003	637GW003A4	**12**	=	02/12/1998						
2-Methylphenol (o-Cresol)	H009GW007	009GW00701	**270**	J	11/10/1994	NA	183	NA	NA	NA	NA
	H009GW007	009GW00702	71	J	04/24/1995						
	H009GW007	009GW00703	**390**	=	09/14/1995						
	H009GW007	009GW00704	79	J	03/20/1996						

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Benzene	H009GW007	009GW00701	11	J	11/10/1994	5	0.32	NA	NA	NA	NA
	H009GW007	009GW00702	10	J	04/24/1995						
	H009GW007	009GW00703	18	=	09/14/1995						
	H009GW007	009GW00704	13	=	03/20/1996						
	H009GW007	009GW00701a	17	S=	03/11/1998						
	H009GW007	009GW00702a	13	S=	09/27/1998						
	H009GW009	009GW00901	2.9	J	11/19/1994						
	H009GW009	009GW00902a	7	=	04/14/1995						
	H009GW009	009GW00903	12	=	09/25/1995						
	H009GW009	009GW00904	6	=	04/05/1996						
	H009GW009	009GW00901a	2	SJ	03/11/1998						
	H009GW009	009GW00902	3	SJ	09/28/1998						
	H009GW010	009GW01001	180	=	11/07/1994						
	H009GW010	009GW01002	77	=	04/25/1995						
	H009GW010	009GW01003	220	=	09/29/1995						
	H009GW010	009GW01004	100	=	04/10/1996						
	H009GW010	009GW01001a	180	S=	03/11/1998						
	H009GW010	009GW01002a	260	SJ	09/28/1998						
	H009GW010	009G001010	20	UJ	07/19/2000						
	H009GW026	009GW02601	17	=	08/13/1998						
	H009GW026	009GW02602	16	S=	09/28/1998						
	H009GW030	009GW03001	25	=	08/12/1998						
	H009GW030	009GW03002	20	S=	09/27/1998						

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Chlorobenzene	H009GW010	009GW01001	1,300	=	11/07/1994	100	11	NA	NA	NA	NA
	H009GW010	009GW01002	480	=	04/25/1995						
	H009GW010	009GW01003	1,200	=	09/29/1995						
	H009GW010	009GW01004	440	=	04/10/1996						
	H009GW010	009GW01001a	740	SJ	03/11/1998						
	H009GW010	009GW01002a	900	SJ	09/28/1998						
	H009GW010	009G001010	230	=	07/19/2000						
	H009GW014	009GW014M6	140	=	06/20/2002						
	H009GW014	009GW014M7	24	=	09/09/2002						
cis-1,2-Dichloroethylene	H009GW007	009GW00702a	2,100	SJ	09/27/1998	70	NA	NA	NA	NA	NA
Methylene Chloride	H009GW007	009GW00701	68	U	11/10/1994	5	4.1	NA	NA	NA	NA
	H009GW007	009GW00702	130	J	04/24/1995						
	H009GW007	009GW00703	68	=	09/14/1995						
	H009GW007	009GW00704	280	=	03/20/1996						
	H009GW007	009GW00701a	980	SJ	03/11/1998						
	H009GW007	009GW00702a	520	SJ	09/27/1998						
	H009GW026	009GW02601	28	J	08/13/1998						
	H009GW026	009GW02602	5	SU	09/28/1998						
	H009GW029	009GW02901	27	J	08/13/1998						
	H009GW029	009GW02902	5	SU	09/28/1998						
	H121GW001	121GW00104	5	J	04/02/1996						

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Trichloroethylene	H009GW007	009GW00701	25	U	11/10/1994	5	1.6	NA	NA	NA	NA
	H009GW007	009GW00702	9	J	04/24/1995						
	H009GW007	009GW00703	12	J	09/14/1995						
	H009GW007	009GW00704	57	=	03/20/1996						
	H009GW007	009GW00701a	360	SJ	03/11/1998						
	H009GW007	009GW00702a	120	S=	09/27/1998						
Vinyl Chloride	H009GW007	009GW00701	720	=	11/10/1994	2	0.019	NA	NA	NA	NA
	H009GW007	009GW00702	360	=	04/24/1995						
	H009GW007	009GW00703	620	=	09/14/1995						
	H009GW007	009GW00704	10	U	03/20/1996						
	H009GW007	009GW00701a	3,000	SJ	03/11/1998						
	H009GW007	009GW00702a	2,900	SJ	09/27/1998						
2,4-Dimethylphenol	H009GW007	009GW00701	1,700	J	11/10/1994	NA	73	NA	NA	NA	NA
	H009GW007	009GW00702	650	=	04/24/1995						
	H009GW007	009GW00703	1,200	=	09/14/1995						
	H009GW007	009GW00704	580	J	03/20/1996						
2-Chlorophenol	H009GW010	009GW01001	5.6	J	11/07/1994	NA	3	NA	NA	NA	NA
	H009GW010	009GW01002	9.6	J	04/25/1995						
	H009GW010	009GW01003	7.2	J	09/29/1995						
	H009GW010	009GW01004	15	=	04/10/1996						
	H009GW010	009G001010	3.3	J	07/19/2000						

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
2-Methylnaphthalene	G637GW003	637GW003A1	**39**	J	04/30/1997	NA	12	NA	NA	NA	NA
	G637GW003	637GW003A2	**23**	=	09/14/1997						
	G637GW003	637GW003A3	**18**	J	12/10/1997						
	G637GW003	637GW003A4	11	=	02/12/1998						
	H009GW030	009GW03001	**20**	=	08/12/1998						
4-Methylphenol (p-Cresol)	G637GW003	637GW003A1	**50**	J	04/30/1997	NA	18	NA	NA	NA	NA
	G637GW003	637GW003A2	10	J	09/14/1997						
	G637GW003	637GW003A3	10	J	12/10/1997						
	G637GW003	637GW003A4	3	J	02/12/1998						
	H009GW007	009GW00701	**4,400**	J	11/10/1994						
	H009GW007	009GW00702	**1,400**	=	04/24/1995						
	H009GW007	009GW00703	**2,700**	=	09/14/1995						
	H009GW007	009GW00704	**1,200**	J	03/20/1996						
Naphthalene	G637GW003	637GW003A1	**240**	=	04/30/1997	NA	0.65	NA	NA	NA	NA
	G637GW003	637GW003A2	**190**	J	09/14/1997						
	G637GW003	637GW003A3	**170**	=	12/10/1997						
	G637GW003	637GW003A4	**120**	=	02/12/1998						
	H009GW001	009GW00101b	**5.6**	J	11/19/1994						
	H009GW001	009GW00102	**4.4**	J	04/17/1995						
	H009GW001	009GW00103	**4.5**	J	09/23/1995						
	H009GW001	009GW00104	10	U	04/02/1996						
	H009GW001	009GW001C1	**4**	J	10/19/1999						
	H009GW001	009G000110	**5**	J	07/19/2000						

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
Antimony	G637GW003	637GW003A1	**10.3**	J	04/30/1997	6	1.5	NA	12	6	5
	G637GW003	637GW003A2	1.9	U	09/14/1997						
	G637GW003	637GW003A3	1.6	U	12/10/1997						
	G637GW003	637GW003A4	1.6	U	02/12/1998						
	H009GW016	009GW01601	**18.8**	J	04/19/1995						
	H009GW016	009GW01603a	10.5	U	09/15/1995						
	H009GW016	009GW01604	4.1	U	03/21/1996						
	H009GW024	009GW02401	**9.1**	J	08/10/1998						
	H009GW024	009GW024C1	**15.5**	=	10/19/1999						
	H009GW024	009GW024N1	21.4	U	01/07/2003						
	G706GW001	706GW001A1	3.8	J	04/30/1997						
	G706GW001	706GW001A2	8.9	U	09/15/1997						
	G706GW001	706GW001A3	6.5	U	12/12/1997						
	G706GW001	706GW001A4	**9.4**	J	02/12/1998						
	G706GW001	706GW001A5	**45.6**	J	07/27/1999						
Barium	G637GW003	637GW003A1	**6,740**	J	04/30/1997	2,000	260	937	223	115	871
	G637GW003	637GW003A2	**4,640**	J	09/14/1997						
	G637GW003	637GW003A3	**2,750**	J	12/10/1997						
	G637GW003	637GW003A4	46.3	=	02/12/1998						
	G637GW003	637GW003M1	**4,000**	=	03/29/2002						
	G706GW001	706GW001A1	539	=	04/30/1997						
	G706GW001	706GW001A2	422	J	09/15/1997						
	G706GW001	706GW001A3	299	J	12/12/1997						
	G706GW001	706GW001A4	1,440	=	02/12/1998						
	G706GW001	706GW001A5	**2,290**	=	07/27/1999						

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.
	G706GW001	706GW001M6	**2,300**		06/20/2002						
	G706GW001	706GW001M7	810		07/13/2002						
	G706GW001	706GW001M8	1,500		09/09/2002						
	G706GW001	706GW001N1	1,080		01/06/2003						
	H009GW027	009GW02701	**21,300**	=	08/12/1998						
Lead	H009GW001	009GW00101a	**17.4**	=	11/18/1994	15	15	3	6	52	NA
	H009GW001	009GW00102	4.8	U	04/17/1995						
	H009GW001	009GW00103	3.8	J	09/23/1995						
	H009GW001	009GW00104	2.7	U	04/02/1996						
	H009GW001	009GW001C1	3	J	10/19/1999						
	H009GW009	009GW00901	**52.6**	=	11/19/1994						
	H009GW009	009GW00902a	**33.5**	=	04/14/1995						
	H009GW009	009GW00903	11.9	J	09/25/1995						
	H009GW009	009GW00904	10.7	=	04/05/1996						
	H009GW016	009GW01601	**20.8**	=	04/19/1995						
	H009GW016	009GW01603a	**27.9**	=	09/15/1995						
	H009GW016	009GW01604	**22.6**	=	03/21/1996						
	H009GW018	009GW01801	8.2	=	04/20/1995						
	H009GW018	009GW01803	**19.8**	J	10/11/1995						
	H009GW018	009GW01804a	11.2	=	04/16/1996						
	H009GW26D	009GW26D01	**27.7**	=	08/13/1998						

Note: Concentrations in bold and outlined text exceed the appropriate screening criteria.
J Indicates an estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.
U Indicates that the concentration was not detected.
S Indicates that the data has not been validated and can only be used for screening.

TABLE 2-7
Groundwater COPCs Retained as COCs
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Parameter	Station ID	Sample ID	Result (µg/L)	Qualifier	Date Collected	MCL	Region III Tap Water RBC	Zone H Max. Shallow Background Conc.	Zone H Max. Deep Background Conc.	Zone G Max. Shallow Background Conc.	Zone G Max. Deep Background Conc.

NA Screening criteria not available for the referenced compound.

TABLE 2-8
Detected Concentrations of Pesticides in Groundwater at Combined SWMU 9
Combined SWMU 9 CMS Report, Zone H, Charleston Naval Complex

Parameter	Sample ID	Station ID	Result (µg/L)	Qualifier	Date Sampled	MCL (µg/L)	EPA Region III Tap Water RBC (HI = 0.1) (µg/L)
4,4'-DDD	009GW01501	H009GW015	0.10000	U	11/22/1994	NA	0.2
	009GW01502	H009GW015	0.10000	=	04/19/1995		
	009GW01503	H009GW015	0.10000	UJ	10/04/1995		
	009GW01504	H009GW015	0.08000	U	04/12/1996		
4,4'-DDE	009GW01501	H009GW015	0.05000	U	11/22/1994	NA	0.2
	009GW01502	H009GW015	0.03000	J	04/19/1995		
	009GW01503	H009GW015	0.06000	UJ	10/04/1995		
	009GW01504	H009GW015	0.08000	UJ	04/12/1996		
4,4'-DDT	009GW01101	H009GW011	0.06000	J	11/05/1994	NA	0.2
	009GW01102a	H009GW011	0.10000	UJ	04/14/1995		
	009GW01103	H009GW011	0.10000	U	09/28/1995		
	009GW01104	H009GW011	0.08000	U	04/10/1996		
alpha-Chlordane	009GW02701	H009GW027	0.44000	=	08/12/1998	2	0.19
beta-BHC	009GW02901	H009GW029	0.09700	=	08/13/1998	0.2*	0.037
delta-BHC	009GW02701	H009GW027	0.28000	=	08/12/1998	NA	0.01
gamma-BHC	009GW02701	H009GW027	0.07600	=	08/12/1998	0.2*	0.052
Endosulfan I	009GW01501	H009GW015	0.05000	U	11/22/1994	NA	22
	009GW01502	H009GW015	0.07000	=	04/19/1995		
	009GW01503	H009GW015	0.06000	UJ	10/04/1995		
	009GW01504	H009GW015	0.04000	U	04/12/1996		
Endosulfan II	009GW03001	H009GW030	0.11000	=	08/12/1998	NA	22
gamma-Chlordane	009GW02701	H009GW027	0.27000	=	08/12/1998	2	0.19
Heptachlor	009GW02001	H009GW020	0.04200	J	08/11/1998	0.4	0.014
	009GW02003	H009GW020	0.04000	U	04/27/1999		
	009GW02004	H009GW020	0.04000	U	12/07/1999		
Heptachlor epoxide	009GW02701	H009GW027	0.06000	=	08/12/1998	0.2	0.007

Notes:
µg/L micrograms per liter
HI Hazard index
= Indicates that the analyte is detected at the concentration shown.
J Indicates an estimated value. A "J" qualifier may signify that the concentration is below the PQL, or that the "J" has been applied as a result of the data validation.
U Indicates analyte not detected above laboratory detection limit.

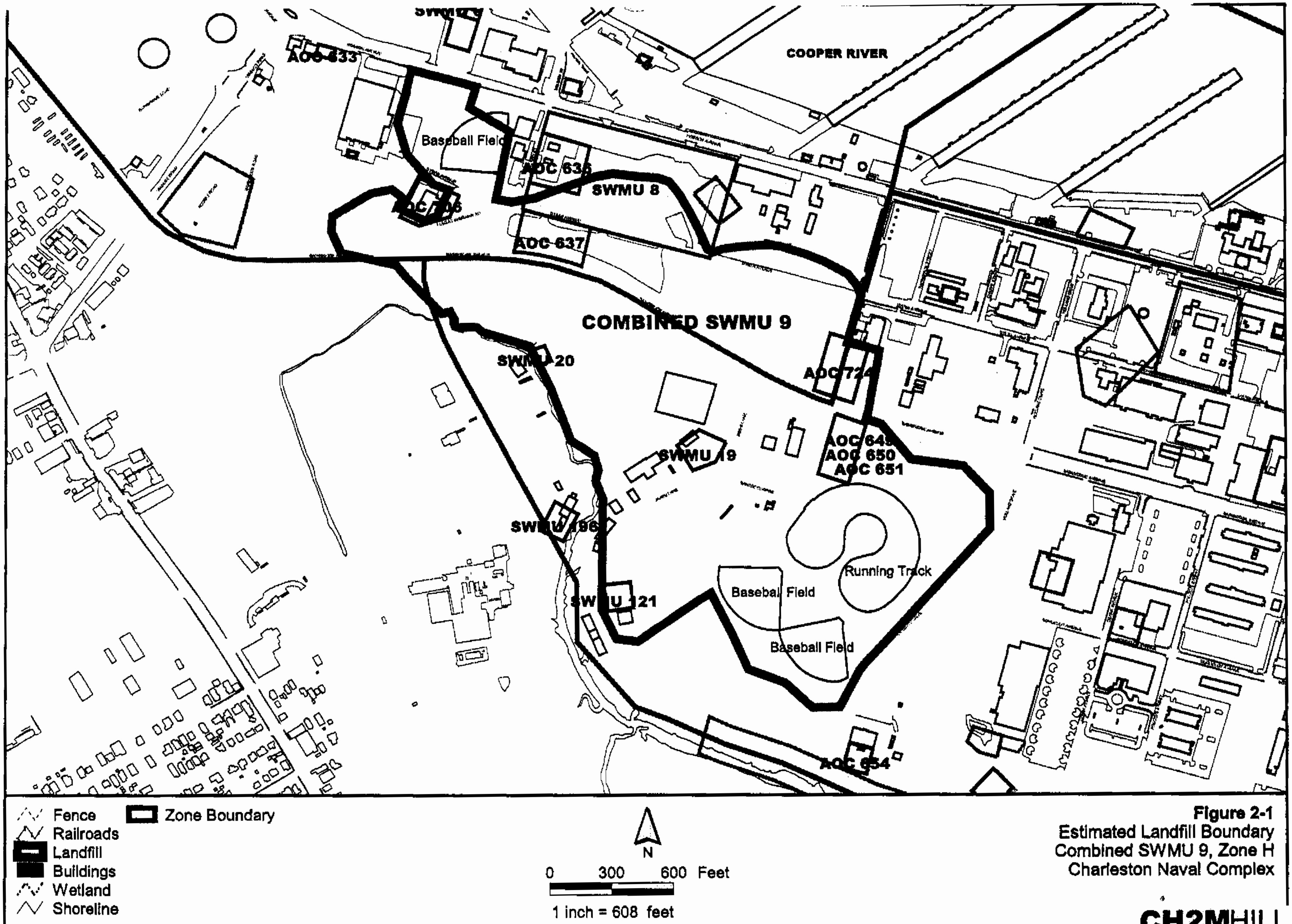


Figure 2-1
Estimated Landfill Boundary
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: c:\proj1.apr, Date: 25 Feb 2004 13:53, User: SNAIK1, EGIS: Charleston Naval Complex - Figure 2-1 Estimated Landfill Boundary

NOTE: Original figure created in color

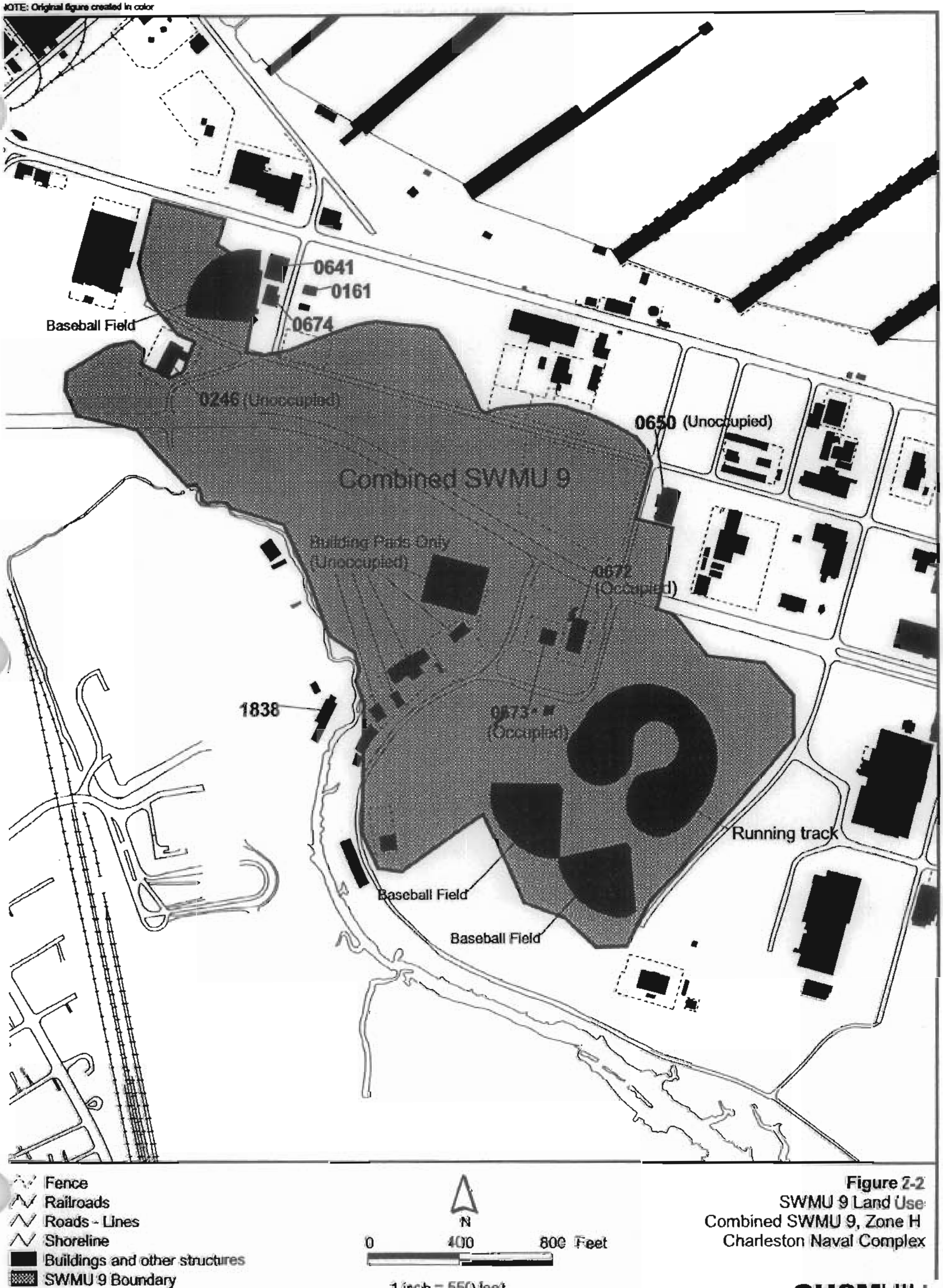


Figure 2-2
SWMU 9 Land Use
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

Path: C:\18gis\Projects\Zone_H\Swmu_9\Aprs\swmu9_v2.apr, Date: 23 Jan 2003 20:40, User: OBEVERLY, EGIS: Charleston Naval Complex - Figure 2-2 SWMU 9 Land Use

NOTE: Original figure created in color

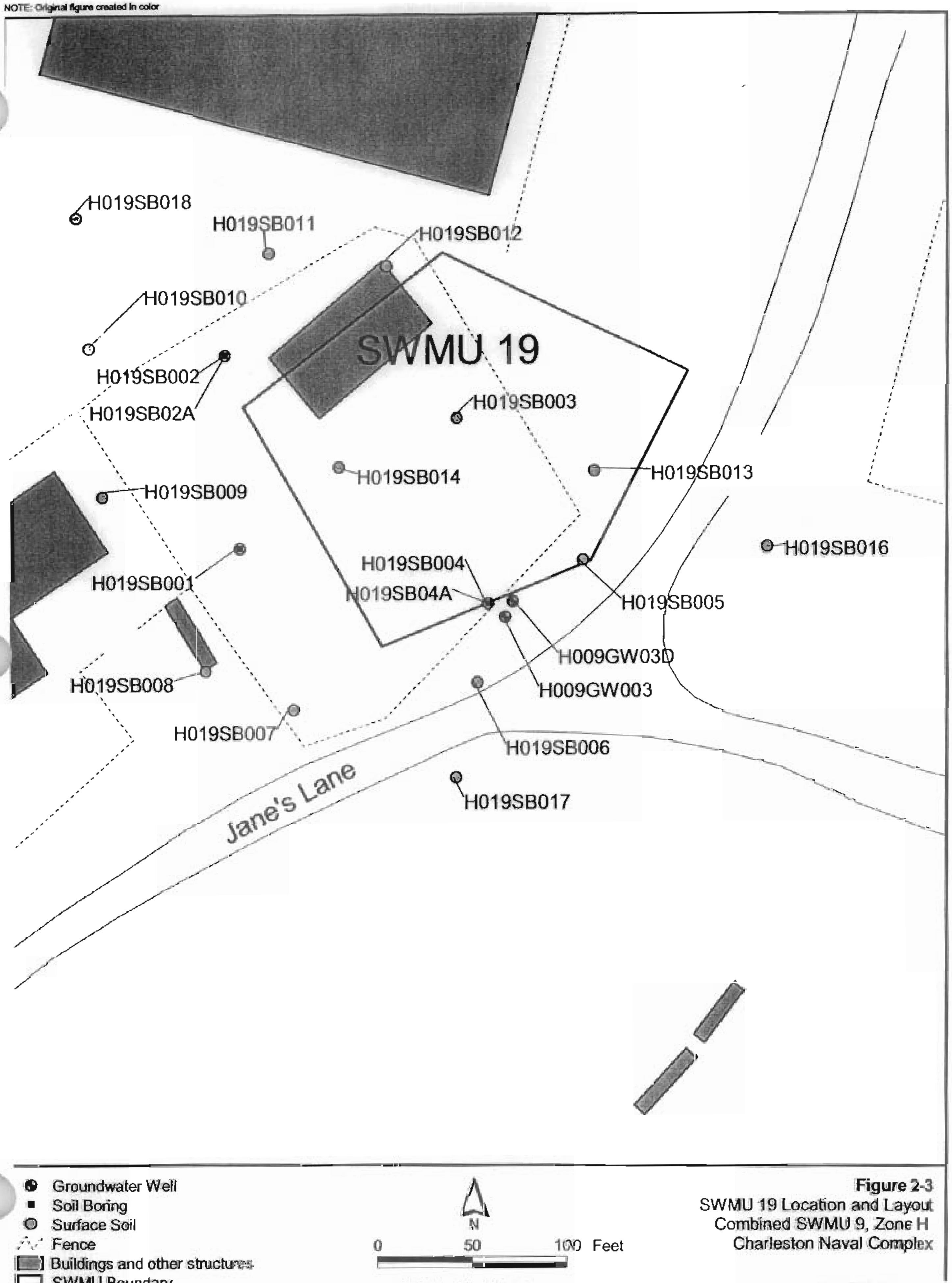


Figure 2-3
SWMU 19 Location and Layout
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

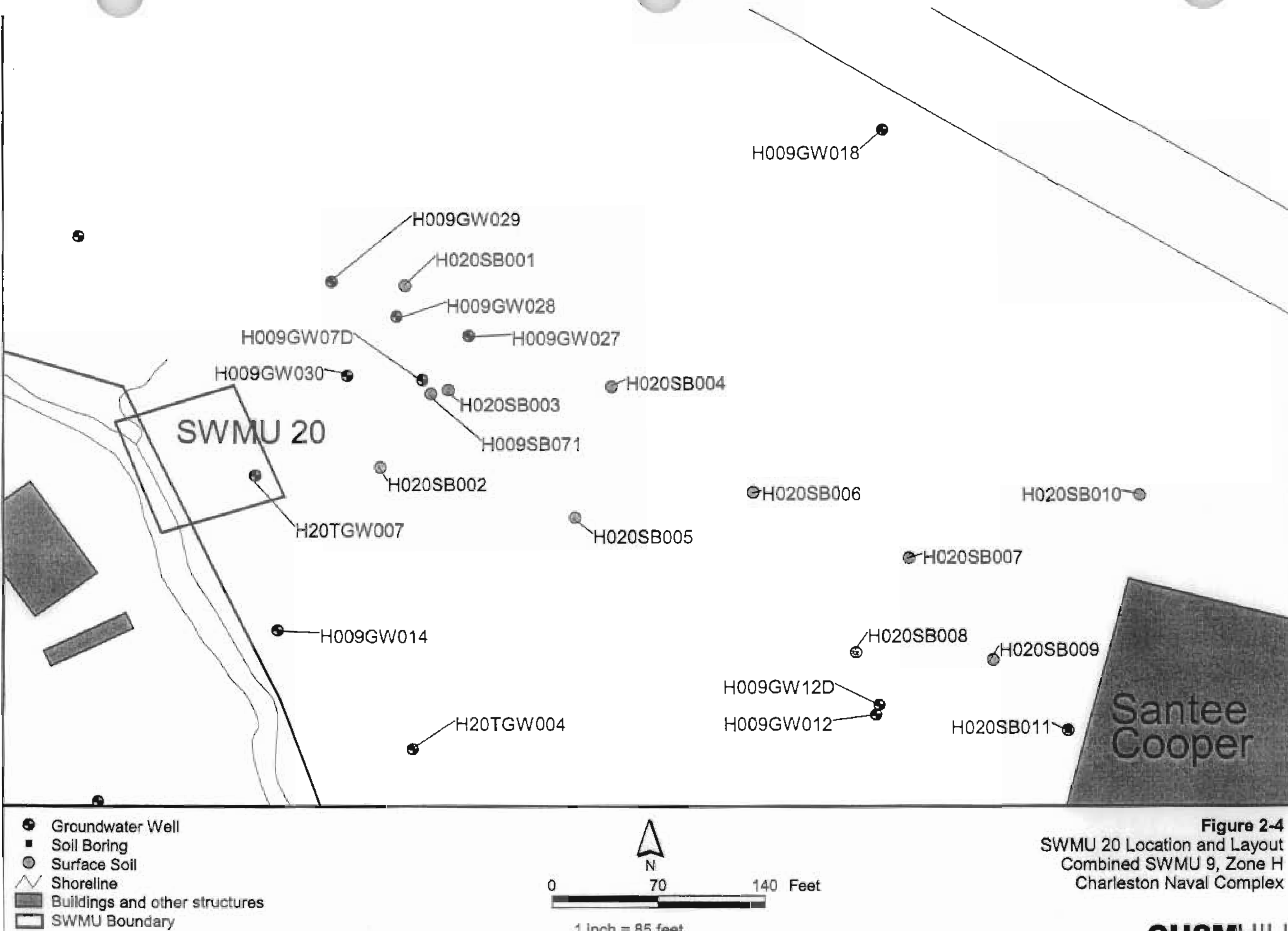


Figure 2-4
SWMU 20 Location and Layout
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: c:\18gis\projects\zone_h\swmu 20\apr\swmu20.apr, Date: 23 Jan 2003 22:42, User: DBEVERLY, EGIS: Charleston Naval Complex - Figure 2-4 SWMU 20 Location and Layout

NOTE: Original figure created in color

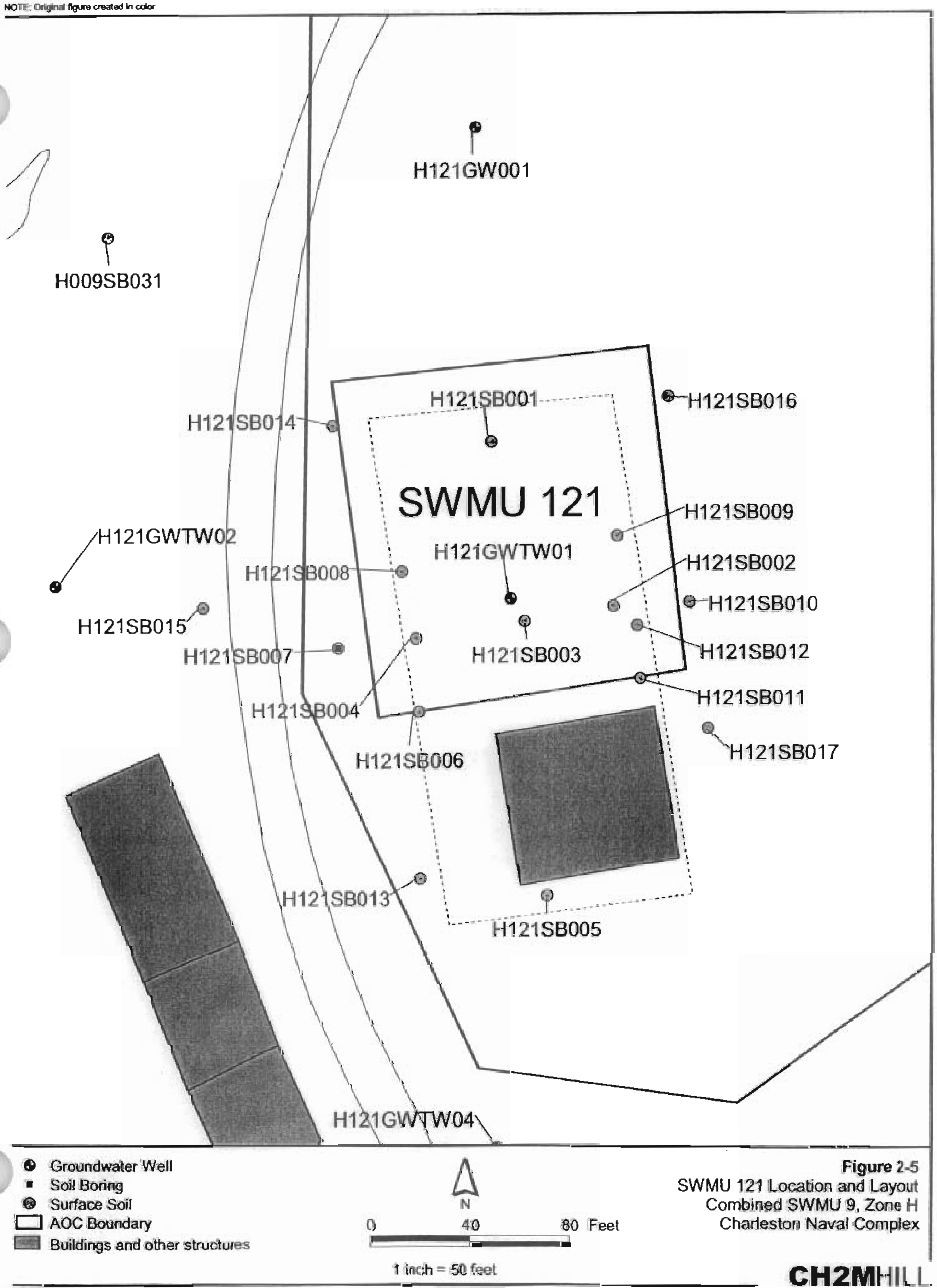


Figure 2-5
SWMU 121 Location and Layout
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

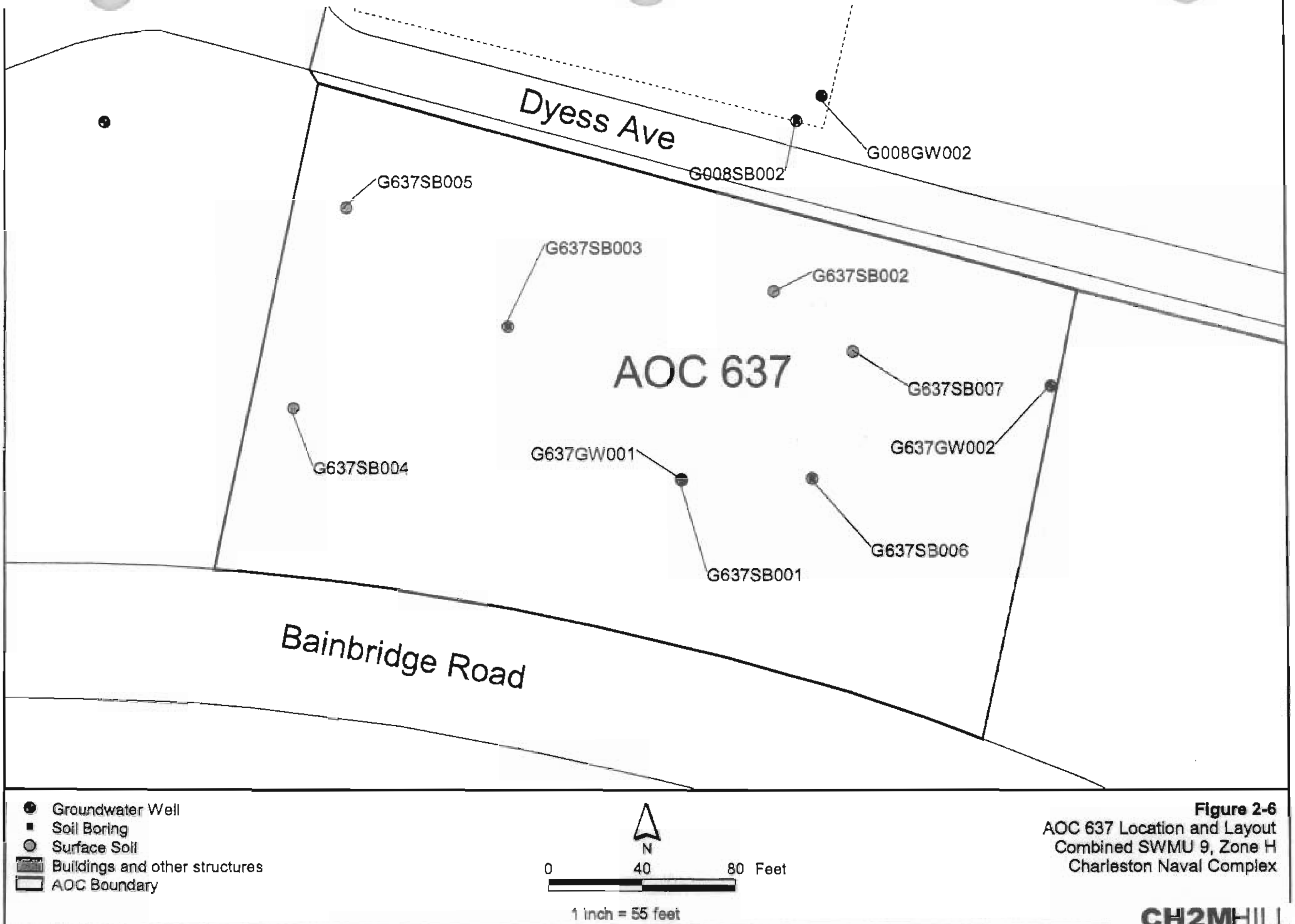


Figure 2-6
AOC 637 Location and Layout
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_H\637\swmu637.apr, Date: 23 Jan 2003 23:05, User: DBEVERLY, EGIS: Charleston Naval Complex - Figure 2-6 AOC 637 Location and Layout

NOTE: Original figure created in color

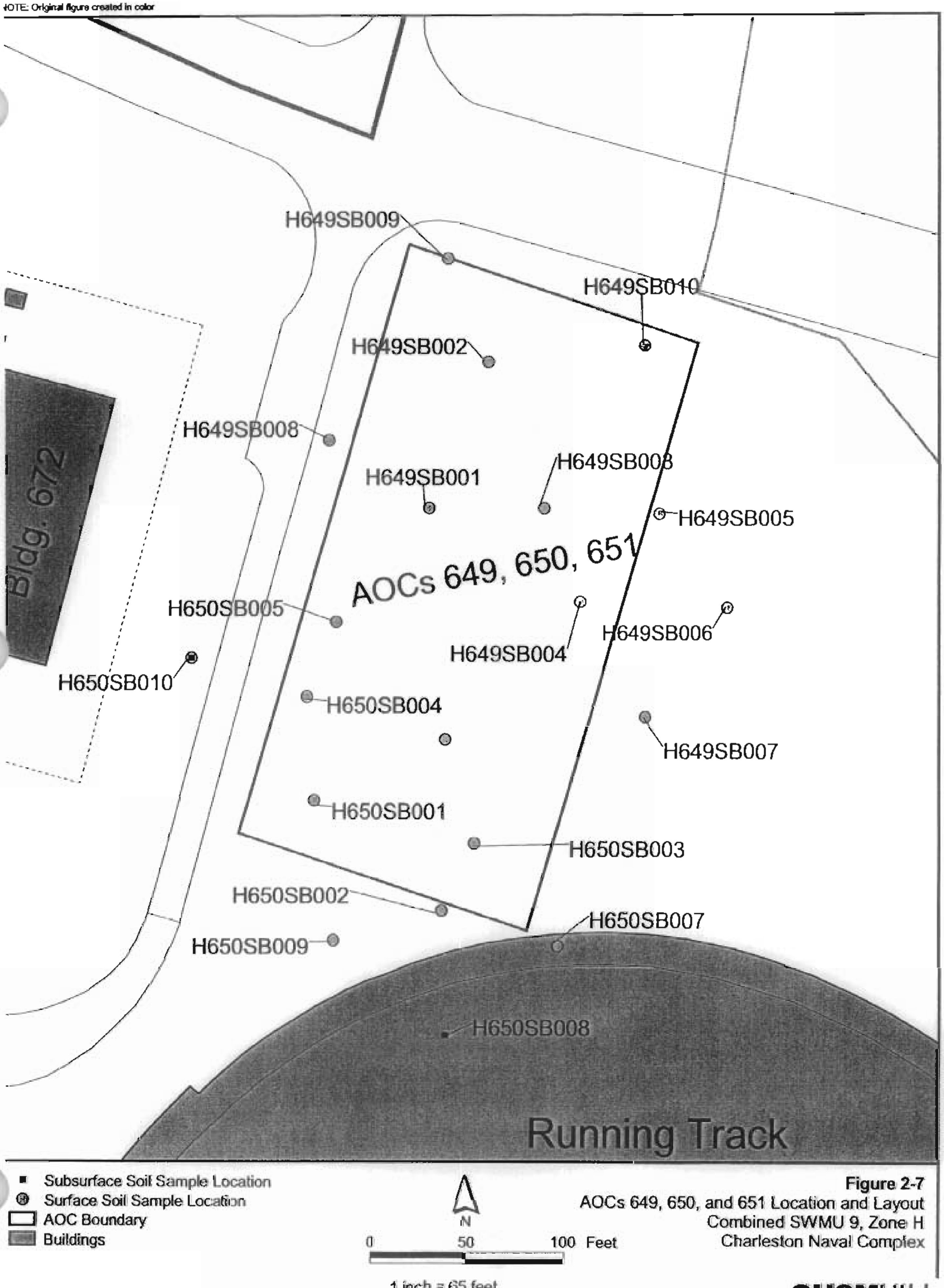
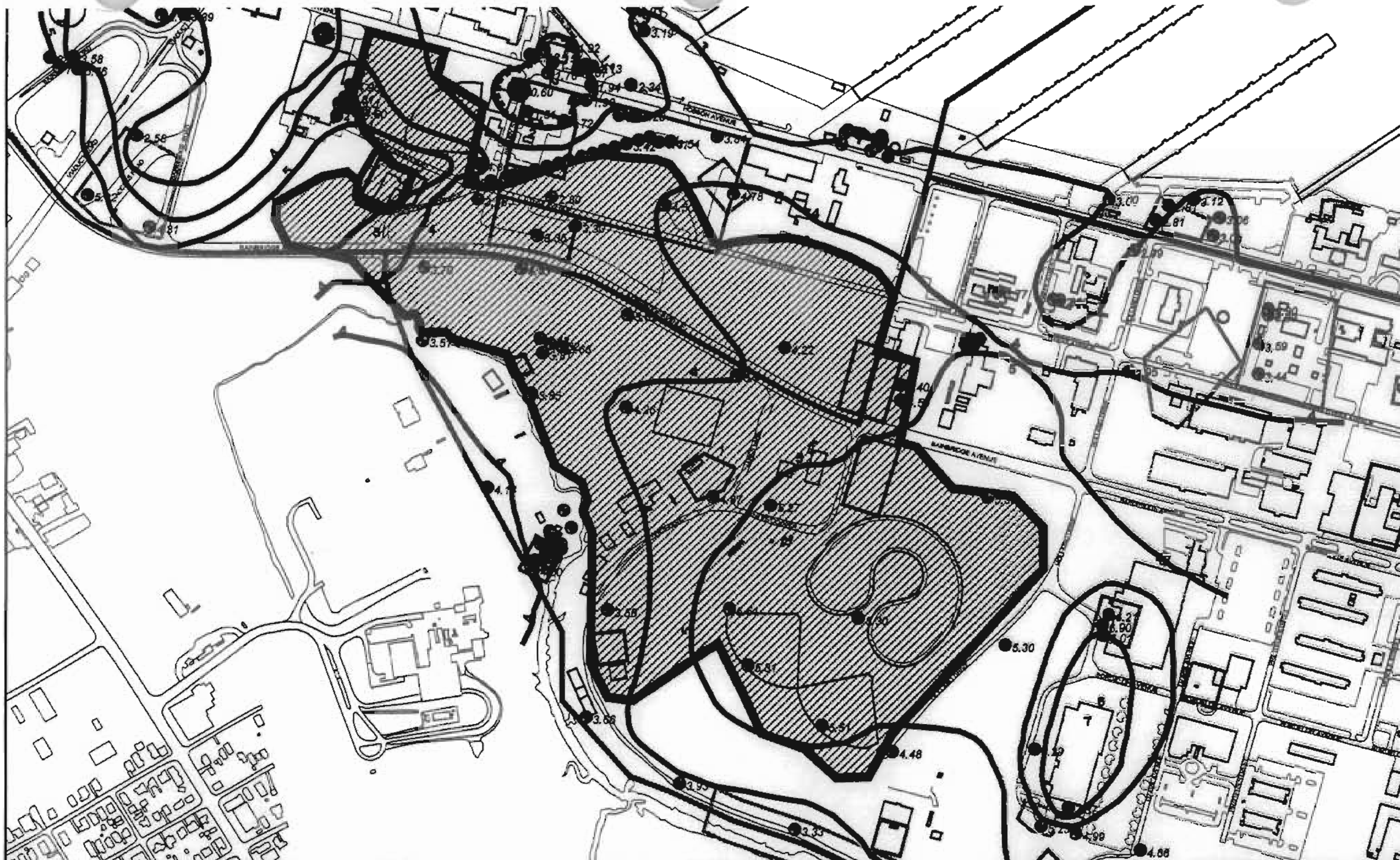


Figure 2-7
AOCs 649, 650, and 651 Location and Layout
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL



Shallow Monitoring Well (shown with June 2002 Groundwater Elevation)
Shallow Groundwater Elevation Contour (elevation in ft MSL)

N

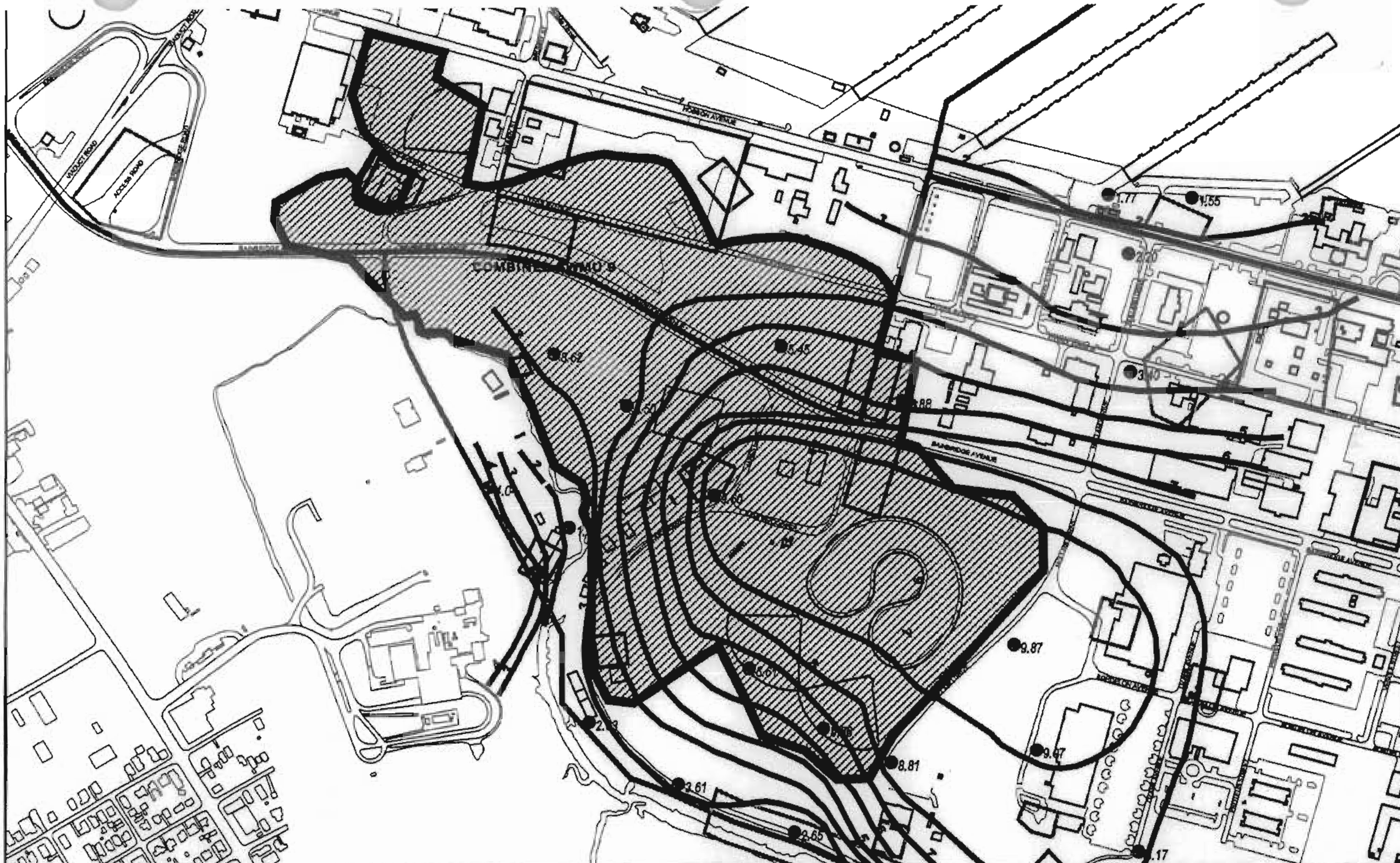
0 300 600 Feet

1 inch = 584 feet

Figure 2-8
Potentiometric Surface Map-Shallow Groundwater
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: c:\proj\1.apr, Date: 25Feb 2004 18:01, User: SNAIK1, EGIS: Charleston Naval Complex - Figure 2-8 Potentiometric Surface Map-Shallow Groundwater



- Deep Monitoring Well (shown with June 2002 Groundwater Elevation)
- Deep Groundwater Elevation Contour (elevation in ft MSL)

N

0 300 600 Feet

1 inch = 584 feet

Figure 2-9
Potentiometric Surface Map-Deep Groundwater
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: c:\proj1.apr, Date: 25 Feb 2004 17:50, User: SNAIK1, EGIS: Charleston Naval Complex - Figure 2-9 Potentiometric Surface Map-Deep Groundwater

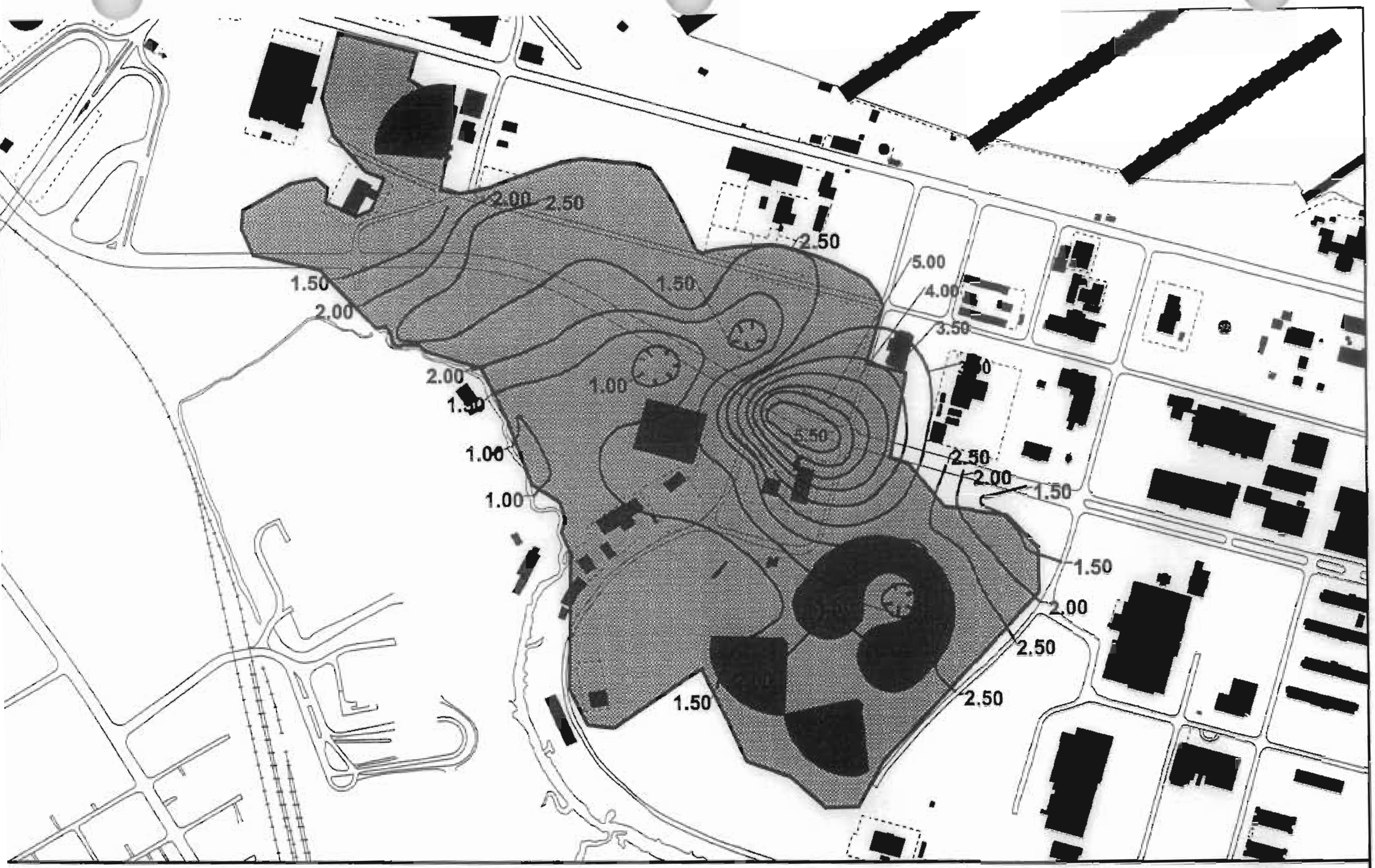
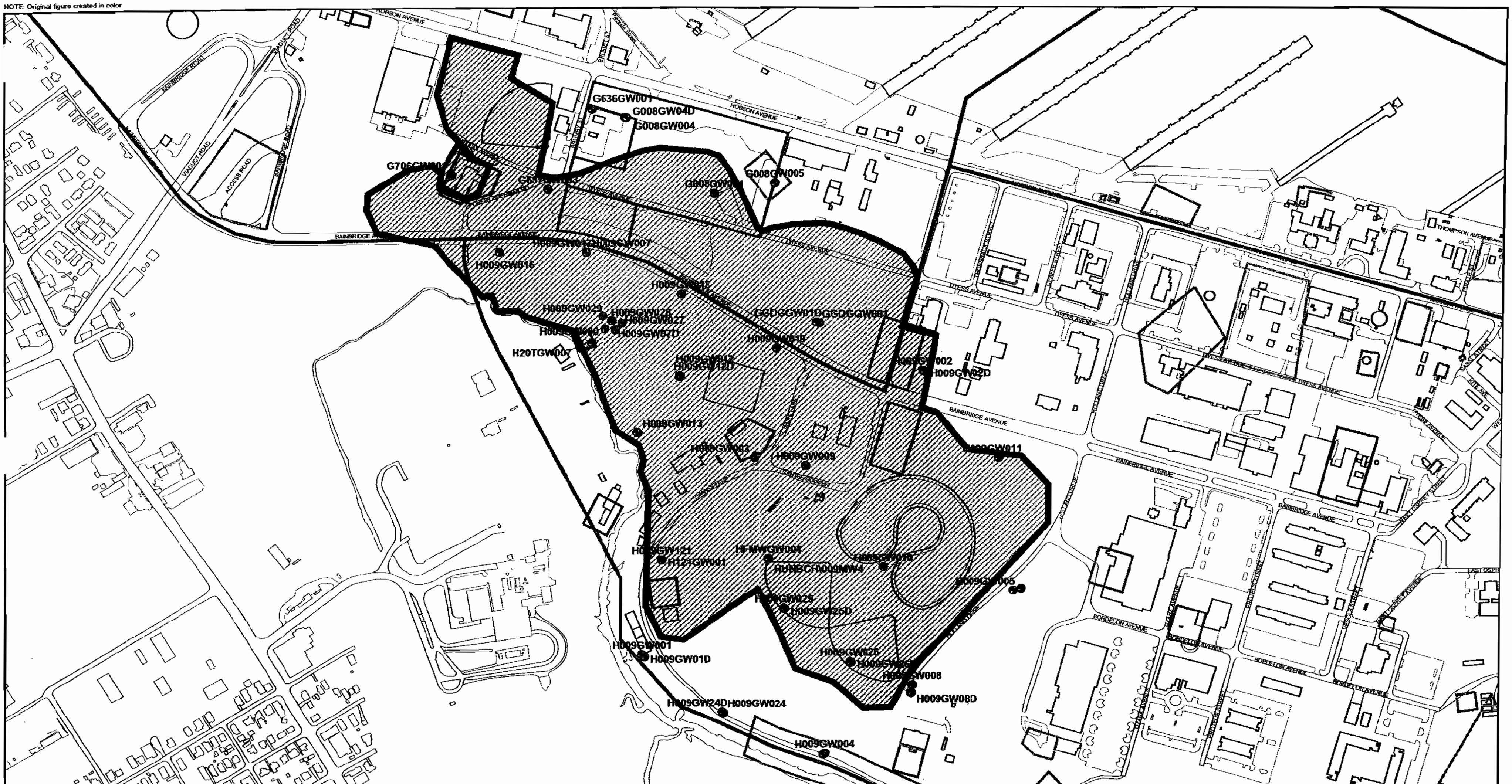


Figure 2-10
Landfill Soil Cover Thickness
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

Path: C:\18gis\Projects\Zone_H\Swmu_9\Apre\swmu9_v2.apr, Date: 23 Jan 2003 21:06, User: DSEVERLY, EGIS: Charleston Naval Complex - Figure 2-10 final Landfill Soil Cover Thickness

NOTE: Original figure created in color



SWMU 9 Area Groundwater Monitoring Wells
Landfill

N
0 200 400 Feet
1 inch = 440 feet

Figure 2-11
Post-RFI Groundwater Sampling Wells
Combined SWMU 9, Zone H
Charleston Naval Complex

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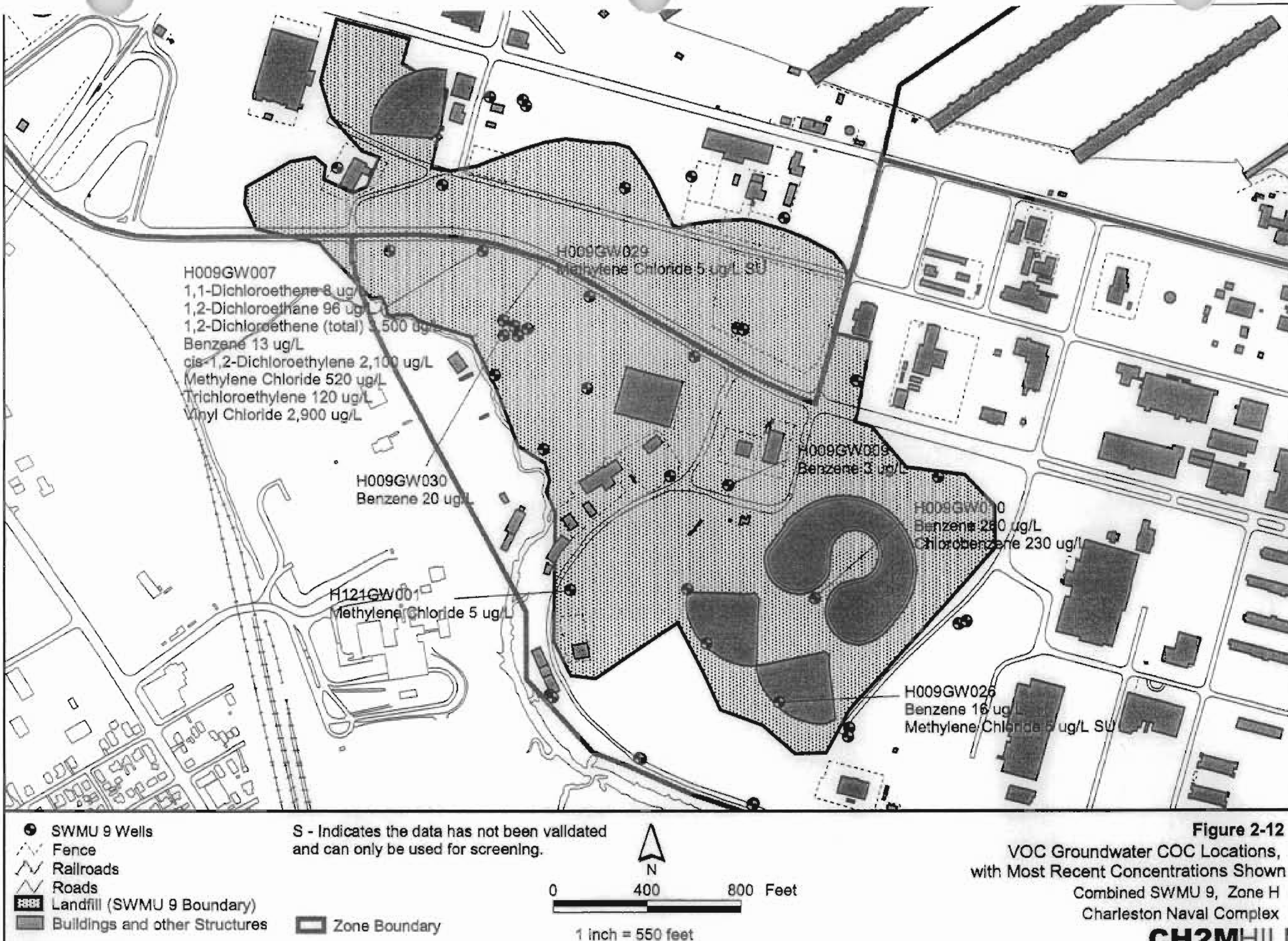


Figure 2-12
VOC Groundwater COC Locations, with Most Recent Concentrations Shown
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: c:\18gis\projects\zone_h\swmu_9\aprs\swmu 9-cnc-egis.apr, Date: 11 Nov 2002 14:56, User: TWILEY

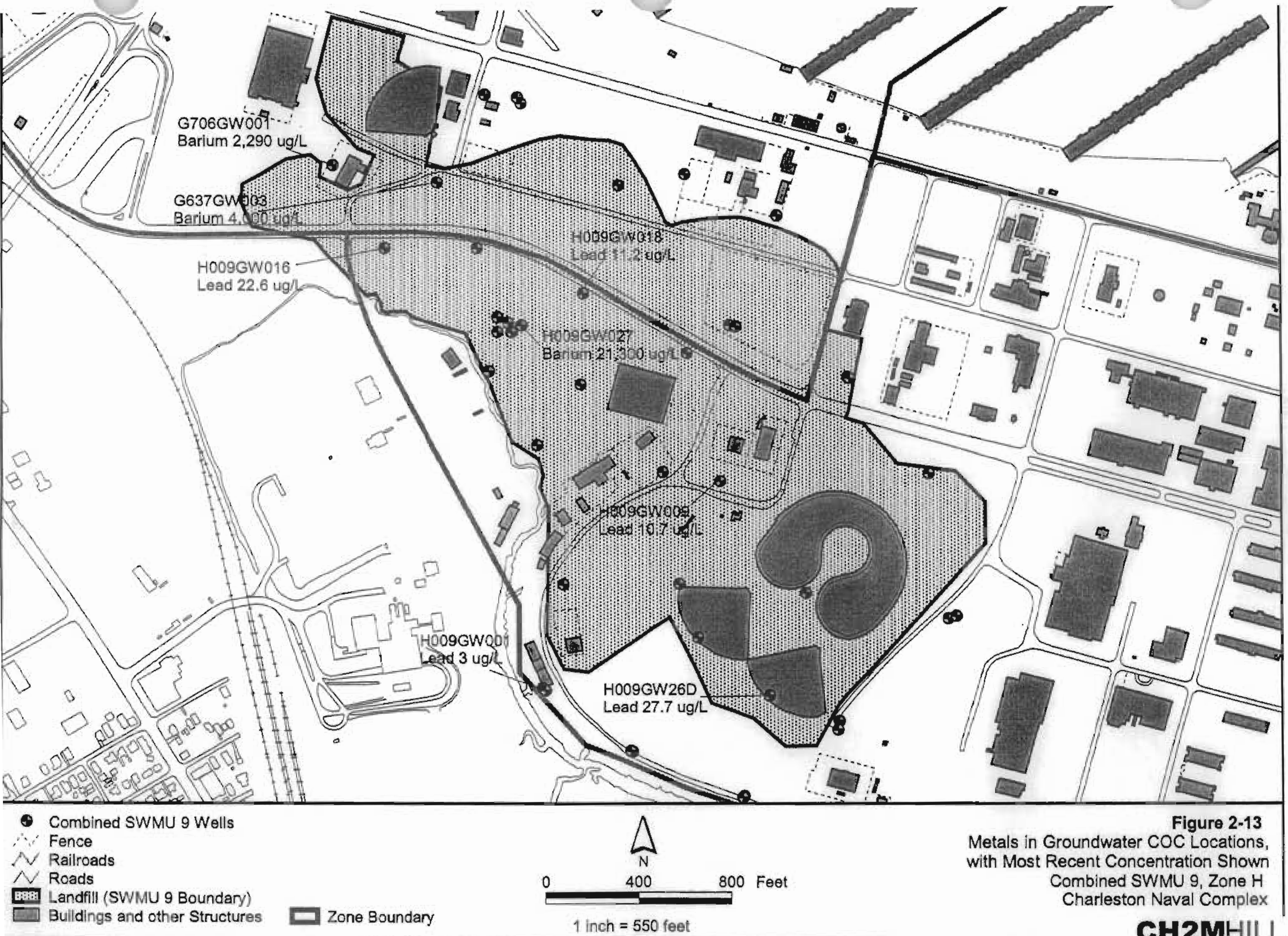
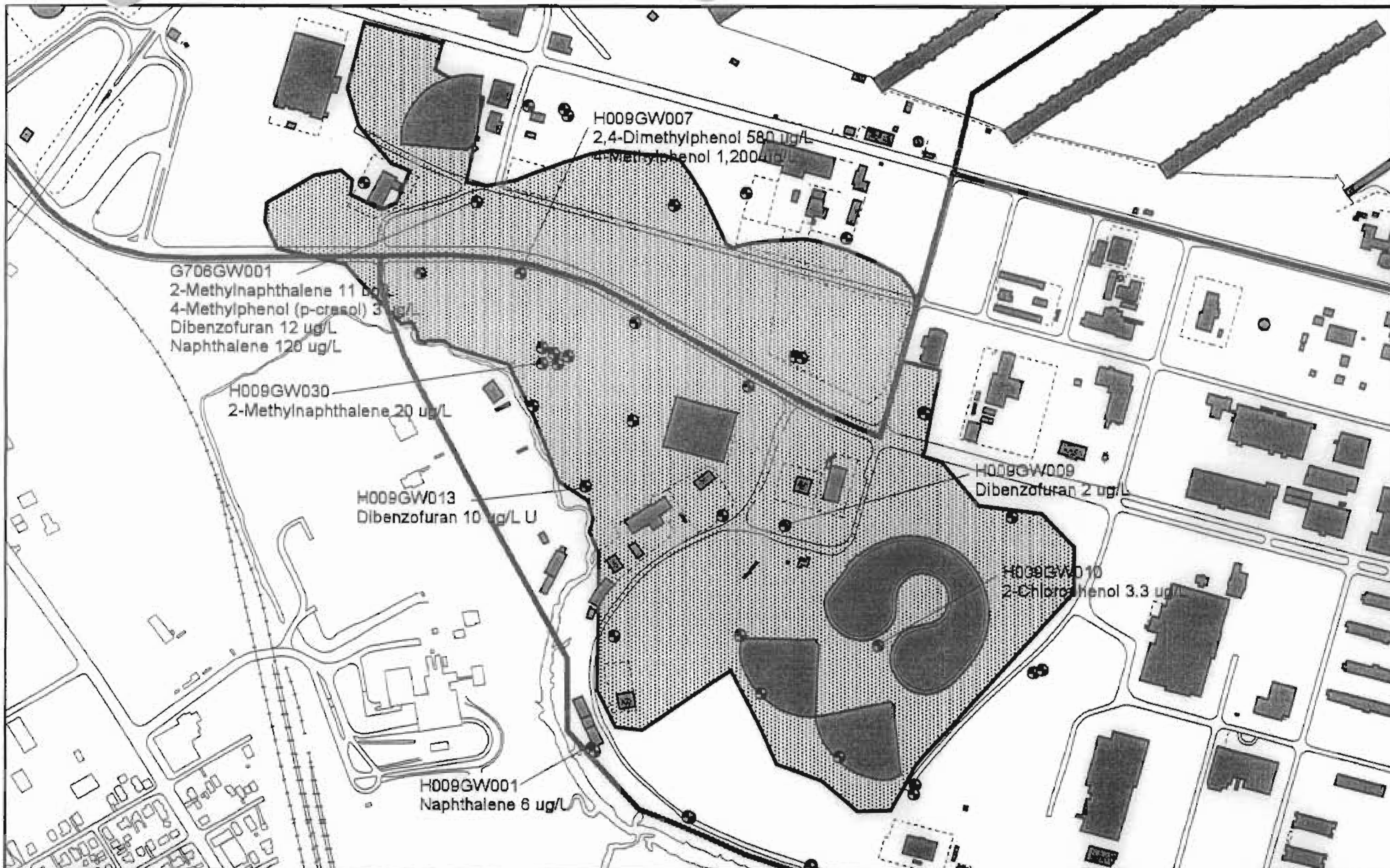


Figure 2-13
Metals in Groundwater COC Locations, with Most Recent Concentration Shown
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL



SWMU 9 Wells
Fence
Railroads
Roads
Landfill (SWMU 9 Boundary)
Buildings and other Structures

U - Concentration is below detection limit

Zone Boundary

N

0 400 800 Feet

1 inch = 550 feet

Figure 2-14
SVOC Groundwater COC Locations, with Most Recent Concentrations Shown
Combined SWMU 9, Zone H
Charleston Naval Complex

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Section 3.0

3.0 Corrective Action Objectives

This section describes the development of CAOs for the site.

3.1 RCRA Corrective Action Goals

The RCRA CA program establishes a wide range of technical and institutional actions and guidelines to achieve the following primary objectives:

- Protect human health and the environment from hazardous constituent releases, and
- Prevent such releases in the future.

To achieve these primary objectives, the RCRA CA program involves the following specific objectives:

- Determine the risks to human health and the environment,
- Evaluate site-specific characteristics and constraints, and
- Identify, develop, and implement appropriate corrective measure or measures to achieve the program objective.

The CMS is the process by which the corrective measures are identified and developed based on the site-specific CAOs.

3.2 Regulatory Standards and Requirements

The identification and evaluation of corrective measures is largely based on the ability of the measure to reliably achieve the CAOs. These objectives are developed based on the MCSs and requirements derived from promulgated federal and state standards, risk assessment results, RFI data, and any applicable guidance and/or policy documents.

The regulatory standards and requirements were developed based on the human health and ecological criteria. The details of the development of these standards and requirements for the site are presented in Sections 3.2.1 and 3.2.2.

3.2.1 Human Health Criteria

During the site BRA, current and potential land use scenarios, public health exposure pathways, and the detected chemical concentrations were evaluated for quantification of the human health exposure risks associated with the site. The environmental media cleanup levels are established to achieve public health protection in accordance with the RCRA CA program goals.

The RCRA CA guidance (EPA, 1994) and the criteria established under Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) require the following remediation goals for the protection of human health:

- Acceptable exposure levels for carcinogens are those concentration levels that represent an excess upper bound lifetime cancer risk of between 10^{-4} and 10^{-6}, and
- Acceptable exposure levels for non-carcinogens are those concentration levels that represent no adverse health effects (below HI of 1).

These public health criteria were considered in developing the CAOs for the site.

3.2.2 Ecological Criteria

Ecological criteria include the promulgated rules and guidelines and the risk-derived standards establishing acceptable exposure levels for ecological receptors, such as flora and fauna, affected by releases of chemical constituents from the site. The BRA evaluated the detected chemical concentrations in comparison to the ecological benchmark concentrations and state and federal standards and guidelines.

3.3 Chemicals of Concern

The general classes of compounds detected in samples collected at the site during the RFI consisted of VOCs, SVOCs, metals, pesticides/PCBs, and herbicides. The RFI data were used in selecting COCs for the BRA (see Section 2.0). The COCs selected for the CMS for the site are detailed in Section 2.0 by each potentially affected environmental media at the SWMUs and AOCs that are part of Combined SWMU 9.

3.4 Identification of Corrective Action Objectives

The CAOs are site-specific media remediation levels developed to achieve the RCRA CA goals. The CAOs for the site are based on the information gathered during the RFI, BRA results, and site-specific remedial objectives. The CAOs were developed based on the following elements:

- Reduce the exposure risks to health and the environment to acceptable levels,
- Cleanup contaminated media consistent with the current and reasonably anticipated future uses,
- Comply with the applicable regulatory standards and requirements, and
- Control contamination source to reduce or eliminate the potential for future releases that may threaten human health and the environment.

Soil, groundwater, sediment, and surface water at the site were evaluated to determine the CAOs. This evaluation is focused on the COCs identified for the environmental media at the site (see Section 3.3). CAO development involves the assessment of the detected concentrations of the COCs to determine the respective MCSs. The CAO development is described below for each medium investigated at the site during the RFI.

3.4.1 Surface Soil

Past landfilling activities preclude the use of the site for future unrestricted land use. Therefore, Combined SWMU 9 is designated for future industrial land use. There are no excessive risks under continued industrial land use, and no COCs were detected in surface soil medium that posed an unacceptable risk for an industrial land use scenario at Combined SWMU 9. Therefore, no CAs are necessary for the surface soil medium to achieve the CAOs.

3.4.2 Subsurface Soil

As described in Section 2.2.8, any subsurface contamination will be managed under a containment remedy component of the presumptive remedy for the SWMU 9 landfill. In addition, the RFI results for subsurface soil medium did not indicate an unacceptable risk for an industrial land use scenario at Combined SWMU 9. Therefore, no further actions are recommended for subsurface soil at Combined SWMU 9 as part of CMS.

3.4.3 Groundwater

Table 3-1 presents a summary of analytical results from samples collected at the groundwater monitoring wells located at the perimeter of Combined SWMU 9 and that are proposed to be the future groundwater monitoring network for the site. The summary is limited to those analytes that were determined to be COCs in groundwater (see Section 2 2.2.7.7.6). As listed in Table 3-1, only two perimeter downgradient wells (H009GW001 and H009GW014) contained a limited number of COCs at concentrations above the screening criteria.

Barium and lead detections were slightly above the MCLs in well H009GW001. These inorganics may have been associated with turbidity (sediment) in groundwater samples that may have contributed metals naturally occurring in formation soils. These metals have not been detected above the MCLs in subsequent sampling, including the two sampling events performed in 2002.

Benzene was detected in well H009GW014 during a sampling event in 1994 at a concentration slightly above the MCL. However, benzene has not been detected above the MCL in the last seven sampling events that have been conducted at well H009GW014. In well H009GW026, it was detected at 17 µg/L and 16 µg/L, above its MCL of 5 µg/L, during two sampling events in 1998.

Chlorobenzene was also detected in well H009GW014 during the June 2002 sampling event at a concentration of 140 µg/L, above the MCL (100 µg/L). However, the concentration of chlorobenzene in well H009GW014 during the following sampling event in September 2002 was substantially lower (24 µg/L) and below the MCL. Chlorobenzene was not detected above the MCL at well H009GW014 in the six sampling events prior to June 2002.

In summary, the limited detections of COCs in the perimeter monitoring wells may have been artifacts of groundwater turbidity, isolated exceedances, and only slightly exceeded the MCLs.

Groundwater Protection Criteria: The human health protection based target levels are three general categories: 1) RBC; 2) ambient water quality criteria (AWQC) – human health, for consumption of water and aquatic organisms and for consumption of organisms only; and 3) MCLs.

The RBCs for screening groundwater quality at Combined SWMU 9 were obtained from EPA Region III RBC Tables (EPA, 2002). These criteria are applicable for areas where human exposure is occurring or likely to occur through potable use of the groundwater or surface water in the release areas. An MCL is used for potable water use areas, and in the absence of an MCL, an RBC value is used for protection of potable water. However, both Shipyard Creek and the Cooper River have brackish water, making it unfit for direct human consumption. Therefore, aquatic organism consumption-based criteria at the point of release within the creek are the pertinent criteria for compliance wells located in the downgradient locations of SWMU 9.

The surface water AWQCs are selected from the National Recommended Water Quality Criteria – Correction (EPA, April 1999). There are two types: 1) AWQC for protection against ingestion of aquatic organism from contaminated surface water, and 2) AWQC for protection against ingestion of surface water and the aquatic organisms from contaminated surface water.

The Combined SWMU 9 groundwater data have been screened against conservative health-based standards and compared to the actual and potential groundwater exposure scenarios. Therefore, evaluation and interpretation of future groundwater monitoring data from Combined SWMU 9 and any groundwater CAs should be based on realistic exposure scenarios. The groundwater data evaluation and approach to address potential groundwater contamination are described in further detail in Section 5.0.

3.4.4 Surface Water

There are currently no human receptors using the surface water in either Shipyard Creek or Cooper River, making the exposure pathway incomplete at the present time. Surface water monitoring to date has not indicated detectable levels of any of the constituents detected in SMWU 9; therefore, no ecological impacts are anticipated from releases from SWMU 9, based on the available information. Therefore, no site-specific CA goals are established for surface water at the site.

3.5 Contingency Plan

Since its closure over 30 years ago, the SWMU 9 landfill has been relatively stable. Its cover has remained intact, the waste has remained covered, and the surface grades have remained flat. Significant differential settling of the landfill or cover has not been observed. Although groundwater contamination has been detected within the boundaries of the landfill, no groundwater plumes that pose an unacceptable risk to human health or the environment have been observed to emanate from the landfill outside the landfill boundary. Thus, based on the past demonstrated stability of the landfill, the landfill is to continue to remain stable and the proposed remedy is expected to be effective at adequately protecting human health and the environment. However, in the event that site conditions change, it may be necessary to implement additional measures or enhancements to the selected remedy.

If site conditions are found to have changed significantly such that additional remedial actions or enhancements to the remedy should be considered, the Navy will contact SCDHEC to discuss what appropriate actions should be taken. It is not possible to predict every potential contingency or change in observed site conditions that could trigger the need for additional remedial action or remedy enhancements. However, some of the possible changes in site conditions that may require additional remedial activities and possible approaches to addressing these changed conditions are listed below.

Observed Changed Condition	Potential Approaches to Address Changed Condition
Erosion of surface cover is observed, leading to waste becoming exposed.	Assess reasons why erosion is occurring, design and implement surface cover enhancement to address erosion.
Excessive surface settling is observed, leading to ponding of water on landfill surface.	Provide additional fill for subsided areas, then grade and hydroseed the affected area.
Perimeter groundwater monitoring wells indicate concentrations of chemicals above applicable risk-based levels (MCLs or salt water chronic toxicity value).	Resample wells, review data trends for well and nearby/surrounding wells. Assess potential risk/exposure pathways. Take further actions, depending on specific site conditions and potential exposure pathways, to prevent unacceptable risks to human health and the environment.

1

TABLE 3-1
COCs in Perimeter Wells
CMS Report, Combined SWMU 9, Zone H, Charleston Naval Complex

Station ID	Sample ID	Sample Date	COC Analyte Detected	Conc.	ProjQual	Units
Shallow Groundwater Zone						
Upgradient Wells						
H009GW005	-	-	None	-	-	-
H009GW008	-	-	None	-	-	-
Downgradient Wells						
G008GW004	-	-	None	-	-	-
G008GW005	-	-	None	-	-	-
G636GW001	-	-	None	-	-	-
GU16GW003	-	-	None	-	-	-
G006GW004						
H009GW001	009GW00101a	11/18/1994	Lead	**17.4**	=	µg/L
H009GW011	-	-	None	-	-	-
H009GW013	-	-	None	-	-	-
H009GW014	009GW01401	11/29/1994	Benzene	**9**	=	µg/L
H009GW014	009GW014M6	06/19/2002	Chlorobenzene	**140**	=	µg/L
H009GW025	-	-	None	-	-	-
H009GW026	009GW02601	08/13/1998	Benzene	17	=	µg/L
H009GW031	-	-	None	-	-	-
H121GW001	-	-	None	-	-	-
Deep Groundwater Zone						
Upgradient Wells						
H009GW05D	-	-	None	-	-	-
H009GW08D	-	-	None	-	-	-
Downgradient Wells						
G008GW04D	-	-	None	-	-	-
H009GW01D	-	-	None	-	-	-
H009GW02D	-	-	None	-	-	-
H009GW07D	-	-	None	-	-	-

Notes: Concentrations in bold and outlined text exceed the appropriate screening criteria.
J Estimated value

Section 4.0

4.0 Corrective Measure Evaluation

This section develops and evaluates the corrective measures alternatives that are appropriate for the remediation of a military landfill, such as Combined SWMU 9. The corrective measure development process consists of the following steps:

1. Establish the presumptive remedy for Combined SWMU 9 as the basis of the corrective measure development.
2. Develop the corrective measure components.
3. Evaluate the corrective measure to address the CAOs and specific evaluation criteria.

4.1 Basis for Corrective Measures Study

A key basis for conducting the CMS for Combined SWMU 9 is the application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (EPA, 1996).

As mentioned in Section 1.1, the presumptive remedy for landfills is containment, i.e., leaving the landfill waste in place, based on EPA's past and repeated conclusion that for certain types of landfills, such as SWMU 9, containment is effective, easily implemented, and provides cost-savings. Application of the containment presumptive remedy to Combined SWMU 9 will streamline the CMS process for Combined SWMU 9 and result in consistent remedy selection and decision-making.

Under the presumptive remedy, the primary CAOs for Combined SMWU 9 will be to prevent migration of contaminated groundwater from the landfill area. The containment of landfill waste will be engineered to protect human health and the environment by eliminating or reducing exposure of potential receptors. Supplemental technologies, such as LTM, maintenance of engineered controls, LUCs, and groundwater containment or treatment, may be implemented to ensure integrity and long-term reliability of the containment corrective measure.

The presumptive remedy for Combined SWMU 9 addresses CAOs for individual SWMUs and AOCs in the landfill footprint.

4.2 Presumptive Remedy Evaluation

To assess the suitability of the presumptive remedy at Combined SWMU 9, the application of the presumptive remedy approach was evaluated on the basis of the decision tree presented in *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* (EPA, 1996), using site-specific information. The results of the evaluation are presented below.

4.2.1 Collect Available Information

Combined SWMU 9 has been investigated and the results of the past investigations are presented in Section 2.0. The majority of the wastes reportedly disposed in the landfill were nonhazardous, such as domestic wastes, construction and demolition debris, and yard trash. Small amounts of industrial wastes have been disposed in the landfill. SWMU 121 included a SAA for hazardous waste. There was no secondary containment at this SAA.

4.2.2 Land Reuse Plans

Combined SWMU 9 area is approximately 120 acres. No future reuse of the site has been specified. LUCs will be applied to prohibit future use or development of the site that threatens the integrity or effectiveness of the remedy or results in unacceptable exposure potential.

4.2.3 Landfill Contents

The landfill contents include municipal waste, such as household garbage and other nonhazardous debris, as well as industrial wastes.

4.2.4 Practicality of Excavation

The landfill area extends approximately 120 acres and the volume of the landfill material is estimated at well over 1 million cubic yards. Further, a significant portion of the landfill wastes lie below the local groundwater table and pose a substantial ecological and resource degradation threat in the event of waste excavation. Therefore, excavation of Combined SWMU 9 is considered not practical.

4.2.5 Appropriateness of Containment

The landfill was closed under the State of South Carolina solid waste regulations and a soil cover exists over the landfill area. The available groundwater monitoring results indicate no unacceptable human health or ecological exposure risks based on the existing land use scenario. Given the types of wastes disposed, the lack of unacceptable exposure risks, and the impracticality of waste removal or treatment, continued in-place containment of wastes at Combined SWMU 9 is considered suitable and appropriate.

4.3 Development of Corrective Measure

Under the presumptive remedy approach, the corrective measure components for landfill remediation include the following:

- Preventing direct contact with landfill contents,
- Minimizing leachate generation and migration of leachate to groundwater,
- Controlling surface water runoff and erosion,
- Controlling the contaminant plume to prevent further migration from source area, and
- Controlling and treating landfill gas.

In addition, the presence of hot spots will require an evaluation of the physical and chemical characteristics and volume of wastes to assess their potential impact on the corrective measures' effectiveness and integrity. Based on the assessment results, hot spot corrective measures, such as containment, removal, and treatment, will also be evaluated.

4.3.1 Corrective Measure Components

The corrective measure components for Combined SWMU 9 were developed based on the CAOs and the presumptive remedy approach (EPA, 1993). The following lists the corrective measure components for Combined SWMU 9 and the associated rationale for the selected corrective measure components.

Corrective Measure Component	Rationale
Evaluate and correct deficient landfill cover	• Prevents direct contact with landfill contents • Reduces potential infiltration into the landfill
Hot spot remediation, if applicable	Minimizes the impact of hot spots on the current and future integrity and effectiveness of corrective measures
Establish grades for positive drainage	• Reduces potential infiltration into the landfill • Facilitates surface drainage and minimizes erosion
Evaluate landfill gas and implement landfill gas remedy, if necessary	Will prevent potential migration and exposure to landfill gas, if present

Corrective Measure Component	Rationale
Groundwater monitoring	Assess the potential for contaminant plume to migrate from source area
LUCs and LTM	• Will ensure the continued integrity and effectiveness of the corrective measure • Will minimize the potential exposure risks

4.3.2 Corrective Measure Description

The corrective measure components identified in Section 4.3.1 are described below.

4.3.2.1 Landfill Cover

A landfill cover currently exists over the Combined SWMU 9 site. The cover includes soil, structures, pavement, and vegetation. The existing landfill cover will be evaluated for deficiencies, such as allowing for direct dermal contact with wastes. On the basis of the evaluation, the existing landfill cover will be supplemented, where necessary, to provide a minimum cover of 12 inches over the impacted areas (containing wastes or waste residues) to eliminate any direct dermal exposure pathway.

These activities will include cover repair and vegetative cover establishment in the areas of site disturbance during the corrective measure implementation. The landfill repair activities will be conducted consistently with the other corrective measure components, such as hot spot remediation, surface drainage, and landfill gas remediation.

4.3.2.2 Hot Spot Remediation

Hot spot remediation options include removal, treatment, and containment to eliminate unacceptable direct contact with contaminants. However, as detailed in Sections 2.0 and 3.0, no COC was found in the surface soil medium at Combined SWMU 9 that posed unacceptable exposure risk for the industrial land use scenario. Therefore, no hot spot remediation is required at Combined SWMU 9.

Subsurface contamination associated with the SWMUs and AOCs located on the landfill do not pose a direct contact exposure risk and will be remediated using the waste containment component.

4.3.2.3 Surface Drainage

Surface drainage will be improved, where necessary, at Combined SWMU 9 to facilitate ready and positive drainage of stormwater. The objectives of surface drainage improvements are to reduce infiltration potential and to minimize the erosion of landfill cover. The surface drainage improvements will consist of grading, establishing drainage ditches, and lining the drainage ditches.

Grading and establishing drainage ditches will be accomplished by placing imported fill soil or by grading the existing soil cover, where sufficient cover thickness exists. The drainage ditch lining may include grass, gravel, or riprap lining, based on the anticipated surface water flow volumes and velocities.

4.3.2.4 Landfill Gas

The available site investigation information does not indicate any significant landfill gas generation that requires venting. However, the available information is limited. Because buildings and structures are located adjacent to the landfill boundary (e.g., Buildings 786, 1831, and 1431), the potential for landfill gas presence and exposure risks will be assessed in a landfill gas investigation on the portions of the landfill adjacent to those buildings and structures. Based on the investigation results, a landfill gas remedy will be developed, if necessary.

4.3.2.5 Groundwater Monitoring

Groundwater monitoring will be conducted routinely to assess the groundwater quality at Combined SWMU 9 and to detect potential migration of contaminants in groundwater. A groundwater monitoring network has already been established at the site (CH2M-Jones, 2002a). The groundwater monitoring program at Combined SWMU 9 will be conducted in accordance with the approved monitoring plan.

4.3.2.6 Land Use Controls and Long-Term Monitoring

LUCs will be implemented to control or eliminate pathways of exposure to landfill wastes and COCs at the site. The specific LUCs will be developed in a LUC implementation plan (LUCIP). Prohibitions on unauthorized intrusive/construction activity will be implemented. Intrusive/construction activity may be authorized if it is conclusively demonstrated that the proposed work will not potentially result in, or enhance the migration of, contamination or increase the potential risk to human health or the environment. Any authorized intrusive/ construction activity will be conducted in strict adherence to the procedures that will be established in the LTM and maintenance plan for Combined SWMU 9 (to be prepared during corrective measure implementation) and any other requirements specific to the authorized intrusive/construction activity.

Through the LUCs, residential development of the site and the potable use of the site's groundwater will also be prohibited. Periodic reviews of Combined SWMU 9 will be conducted to ensure the long-term integrity of the remedy and effectiveness of the LUCs. A groundwater monitoring program (see Section 4.3.2.5) will also be implemented. A re-evaluation of the site may be performed during the LTM program to determine whether changes to the site restrictions and monitoring frequency is required or appropriate.

4.4 Corrective Measures Evaluation

The corrective measures evaluation process identifies and analyzes the potentially feasible CA options to aid in the formulation of a final CA for the site. Corrective measure components are developed to address the CAOs under a presumptive remedy approach.

Each corrective measure component identified in Section 4.3 was evaluated for its potential to eliminate, control, or reduce unacceptable risk to human health and the environment, based on effectiveness, ease of implementation, and cost. In addition to the individual assessment, a comparative analysis was performed to determine the relative and holistic performance of the components. The analysis focused on sub-factors and criteria most pertinent to each site, as well as the scope and complexity of the proposed action.

4.4.1 Corrective Measures Evaluation Criteria

The corrective measure components are screened according to four broad criteria: technical, human health and environmental, institutional, and cost. These screening criteria include the following specific criteria:

- Protection of human health and the environment,
- Attainment of CAOs,
- Source control and mitigation of future releases,
- Compliance with applicable standards for waste management,
- Long-term reliability and effectiveness,
- Reduction in toxicity, mobility, or volume of wastes,
- Short-term effectiveness,
- Implementability, and
- Cost.

These criteria are described in the following paragraphs.

- **Protection of human health and the environment.** Corrective measure components must provide short-term and long-term protection of human health and the environment. Protection can be provided by reducing the exposure risks to acceptable levels using corrective measure components, such as containment and institutional controls. Therefore, the protection of human health and the environment does not necessarily involve permanent treatment of contaminated media.

- **Attainment of CAOs.** The corrective measure is evaluated for its potential to achieve CAOs for Combined SWMU 9. Estimated time period required to achieve CAOs is also evaluated.

- **Source control and mitigation of future releases.** Source control is necessary to prevent further spread of contamination within a medium and to prevent or mitigate future releases to other media that may threaten human health or the environment. A cleanup may become perpetual without appropriate source control measures.

- **Compliance with applicable standards for waste management.** The corrective measure is evaluated to determine the applicable federal and state requirements and procedures to comply with such requirements governing waste management during the CA. Managing wastes generated during the CA is also addressed under this evaluation factor.

- **Long-term reliability and effectiveness.** Potential track record of the remedy is evaluated for the conditions specific to the site. The useful life (the length of time that effectiveness can be maintained) of the remedy is considered, as the effectiveness may deteriorate with time. Operation, monitoring and maintenance options that are necessary to ensure the reliability of the remedy performance and to extend the useful life of the component are also considered.

- **Reduction in toxicity, mobility, or volume of wastes.** In general, treatment components are preferred because they reduce the potential for future risks to human health and the environment through reduction in toxicity, mobility, or volume of wastes. In some instances, the short-term risks associated with certain CAs may outweigh the potential long-term benefits.

- **Short-term effectiveness.** Short-term effectiveness is evaluated to determine the risk to members of the public, personnel on site, and the environment when CA activities are conducted at the site. Factors to be considered include fire, explosion, exposure to hazardous substances, and other threats associated with treatment, excavation, transportation, and disposal.

- **Implementability.** Implementability refers to the practical aspects of employing the corrective measure. Factors to consider include administrative activities (e.g., permits and rights-of-way) and the time to perform them; constructability; and availability of resources (e.g., utilities, construction skills and materials, and disposal facilities).
- **Cost.** Consideration of cost is especially relevant when there are several corrective measure options that offer equivalent protection of human health and the environment but vary widely in cost. Cost does not need to be considered if only one remedy, such as the proposed containment presumptive remedy, is developed. However, for a comprehensive evaluation of the proposed corrective measure, the cost evaluation in this CMS includes factors such as capital costs and O&M costs.

4.4.2 Corrective Measures Evaluation Results

The containment presumptive remedy developed for Combined SWMU 9 was evaluated based on the evaluation criteria recommended in the RCRA Corrective Action Plan (EPA, 1994). The results of this evaluation are presented below.

4.4.2.1 Protection of Human Health and the Environment

The containment presumptive remedy provides adequate current and future protection to human health and the environment through the implementation of the containment remedy, LUCs, and LTM. No current unacceptable exposure risks have been identified for human health or the environment, and the remedy is expected to continue to maintain and control exposure risks at the site to within acceptable level of protection.

4.4.2.2 Attainment of Corrective Action Objectives

The corrective measure would attain the CAOs, including the attainment of the media cleanup objectives. At present, no environmental medium at Combined SWMU 9 presents an unacceptable risk based on the planned industrial land use due to the presence of wastes or waste residues. The remedy will include correcting landfill cover deficiencies, if any, and establishing an LTM program at the site to verify and maintain the integrity of the remedy and the remedy protectiveness of human health and the environment.

The site groundwater will be monitored during the LTM of the site. A contingency remedy would be developed and implemented, in the event that the groundwater quality criteria exceed the MCSs. The type, scope and a schedule of the groundwater contingency remedy would be developed based on the nature of the exceedance observed in the site groundwater.

4.4.2.3 Source Control and Mitigation of Future Releases

The contamination sources (landfill wastes and waste residues from AOCs and SWMUs within the landfill footprint) will be contained by the existing landfill cover and the landfill cover remedy components. The future releases are mitigated by the landfill cover and surface drainage improvements. In addition, a LTM program will be implemented that will include inspecting and repairing the constructed remedy components and restricting land use activities to ensure the integrity of the remedy over time to prevent future releases.

4.4.2.4 Compliance with Applicable Standards for Waste Management

The containment presumptive remedy is not expected to generate contaminated wastes, and therefore, is not expected to trigger waste management regulations. The remedy implementation is anticipated to generate general construction debris and trash, which will be managed in accordance with the state and local non-hazardous solid waste management requirements.

4.4.2.5 Long-Term Reliability and Effectiveness

Implementation of the remedy components would utilize reliable and readily implementable methods and measures. These methods and measures in combination with planned LTM and the application of LUCs would provide adequate long-term effectiveness of the remedy.

4.4.2.6 Reduction in Toxicity, Mobility, or Volume of Wastes

Reduction of mobility of the surface soil contaminants through containment will be achieved by eliminating the direct dermal exposure pathway. Some reduction of toxicity and/or volume could result from biodegradation, natural dispersion, dilution, or other attenuating factors. The anticipated reduction in toxicity, mobility or volume of wastes at Combined SWMU 9 is consistent with the basis of the presumptive remedy for military landfills, EPA's presumptive remedy for CERCLA Municipal Landfill Sites establishes the waste containment for landfills because the volume and types of wastes in landfills, such as Combined SWMU 9, generally makes treatment impracticable (EPA, 1993).

4.4.2.7 Short-Term Effectiveness

No significant increase in the short-term risk for exposure to wastes or waste constituents is anticipated during the implementation of the remedy. As described in Section 4.4.2.4, no contaminated wastes are expected to be generated during the remedy implementation.

Potential for erosion and sediment transport is anticipated during the site grading and construction activities. This potential will be minimized through the use of best management practices (BMPs) for erosion control. In addition, some exposure risk may exist for the workers for the landfill gas investigation at the site. This risk will be managed by protecting the workers through the use of personal protection equipment.

4.4.2.8 Implementability

The implementation of remedy is both technically and administratively feasible and practicable. The EPA guidance also requires that the remedial alternatives be evaluated for regulatory acceptance and public acceptance. These evaluations will be addressed through the issuance of Statement of Basis for public comment, following the approval of SCDHEC. The public comments received will be responded to and the responses will be incorporated into the remedy components for implementation.

4.4.2.9 Cost

The estimated costs for the proposed containment remedy implementation at Combined SWMU 9 are presented in Appendix C. The capital cost for the construction of the remedy components, including the investigative activities (e.g., landfill gas investigation) is estimated to be approximately $291,820. The present worth O&M costs for the LTM and maintenance of the site are $797,119 (this cost includes sampling and reporting and routine landfill inspection and maintenance) over a 30-year period. Assuming an annualized inflation rate of 3 percent and a discount rate of 5 percent, the total cost for implementing the proposed remedy and maintaining it for a 30-year period is approximately $1,088,940 in present-day dollar terms.

The cost estimate does not include an estimate of contingency costs for groundwater remediation, if necessary in the future. This is because the type and scope of a potential groundwater contamination scenario requiring remediation and the probability of such an occurrence could not be established at the present time.

4.4.3 Corrective Measures Evaluation Summary

The proposed containment remedy minimizes human and ecological exposures to landfill wastes and impacted surface soil at Combined SWMU 9. The proposed remedy accomplishes the following remedy objectives:

- Eliminates unacceptable exposure risks to human health and the environment, including the elimination of direct dermal exposure risks to wastes and waste residues by providing a minimum of 12 inches of soil cover over existing wastes and waste residues;
- Identifies and remedies, if necessary, the potential for landfill gas present in and around the occupied structures within Combined SWMU 9;
- Stabilizes the containment remedy through surface drainage restoration, where necessary; and
- Implements an LTM and maintenance program to preserve the integrity and to ensure the protectiveness of the remedy.

This remedy does not satisfy the regulatory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element because removal or treatment of wastes found at the site was deemed to be impractical. Instead, it was determined that a presumptive remedy approach providing for waste containment was more appropriate and adequately protective.

Section 5.0

5.0 Detailed Development of Corrective Measure

The presumptive remedy components described in Section 4.0, including the scope, methods, and measures, are presented in detail in this section.

5.1 Landfill Cover

As described in Section 4.0, a landfill cover consisting of soil, pavement, structures, and vegetation currently caps the SWMU 9 landfill. The objectives of the landfill cover component of the presumptive remedy is to eliminate direct dermal exposure to wastes and waste residues and to minimize infiltration. To achieve these remedial objectives, the following performance standards for the landfill cover were developed:

- The surface soil (top 1 foot) medium considered for direct dermal exposure will be free of landfill wastes.
- The wastes and waste residue concentrations resulting in unacceptable direct dermal exposure risks will be covered with a minimum of 1-foot-thick soil cover.
- Additional soil cover will be installed to a permeability equal to or less than $1x10^{-5}$ centimeter per second (cm/sec) (SCDHEC Solid Waste Regulations) and will be adequately sloped to allow effective surface drainage.

The installation of additional landfill cover will require completion of certain pre-construction data collection and construction activities. These activities are described in Sections 5.1.1 and 5.1.2.

5.1.1 Landfill Cover Assessment

A cover assessment was performed during the RFI to determine the thickness of the existing cover and to develop a topographic map of Combined SWMU 9. No significant disturbance activities have been conducted at the site since the completion of the topographic mapping. The existing topographic site map is considered current and no additional topographic data needs exist.

The existing cap has been in place for approximately 30 years. During that time, it has functioned effectively to preclude direct contact with landfill waste and to allow effective surface drainage. On the basis of past performance and the current conditions at the site, the existing cap is expected to continue to provide adequate containment and cover of the waste, particularly when enhanced with the additional cover refinements proposed herein.

The RFI activities included the assessment of the soil cover thickness that currently exists over Combined SWMU 9. The assessment identified some areas where the cap thickness is less than 1 foot and may be deficient to ensure prevention of direct dermal exposure. Approximate site areas with deficient cover thickness are identified on Figure 5-1.

A cover assessment will be conducted prior to the corrective measure implementation to map the boundaries of the deficient cover areas identified on Figure 5-1. The assessment activities will include hand augering at 50 feet centers to map the area with cover thickness less than direct dermal protection standard (1 foot). The cover assessment will also include identification of excessive erosional areas and apparent subsidence locations.

The areas identified during the cover assessment activities will be surveyed and the survey information will be integrated into the existing topographic information for the site.

5.1.2 Landfill Cover Remediation

The landfill cover remediation activities will include the following tasks:

- Correcting the soil cover thickness to prevent direct dermal exposure to wastes, and
- Correcting the excessive erosional areas, if any, and locations with differential settlement to enhance surface drainage.

The soil cover placed on Combined SWMU 9 as part of the landfill cover component of the remedy will consist of clayey soil that will achieve a maximum permeability of 1×10^{-5} cm/sec. The soil will be placed in lifts and compacted to achieve the target permeability results. The thickness of the additional soil cover will vary based on the required correctional thickness and the surrounding grades. The final surface of the corrected soil cover will be graded to result in a ready and positive drainage.

For the purposes of cost estimation, approximate site areas with deficient soil cover shown on Figure 5-1 are assumed to require an average of 1-foot cover. In addition, approximately 1 acre is assumed to require cover and grading to correct erosion and subsidence areas.

5.2 Surface Drainage

The remedy components will include improvement of surface drainage at Combined SWMU 9, where necessary, to reduce infiltration and minimize erosion. The surface drainage improvements will consist of the following:

- Regrading the landfill cover, where necessary, to facilitate drainage,
- Establishing drainage ditches,
- Maintaining/establishing vegetative cover over the landfill to minimize erosion, and
- Lining the drainage ditches with grass, gravel, or riprap, as necessary, to minimize erosion and sediment transport.

Regrading will be accomplished by placing imported fill soil or by grading the existing soil cover, where sufficient cover thickness exists. The new fill or the disturbed cover material will be placed and compacted in a manner similar to the landfill cover repair (see Section 5.1).

The drainage ditches will be established where conveyance of surface water is hindered or is resulting in excessive erosion. The drainage ditches will be constructed by placing imported fill soil or by grading the existing soil cover, where sufficient cover thickness exists. The drainage ditches may be lined with grass, gravel, or riprap, based on the anticipated surface water flow volumes and velocities.

Some existing landfill cover area may require the establishment of a vegetative cover to minimize erosion and sediment transport. The cover area will be revegetated with native grasses that have better viability and require low maintenance.

For the purposes of cost estimation, it is assumed that approximately 10 acres of the site will require establishment of vegetative cover. In addition, there will be approximately 1,000 linear feet of drainage ditch, of which approximately 500 linear feet will require gravel or riprap lining.

5.3 Landfill Gas

Generation of landfill gas is a potential concern with any landfill that has received wastes containing organic matter. A soil gas investigation was conducted during the RFI, and the results of the investigation did not indicate any significant landfill gas generation that may require venting. However, the available landfill gas information for the SWMU 9 landfill is limited. Several buildings and structures are located on or adjacent to the landfill boundary. An investigation will be conducted to characterize the potential for landfill gas presence in the Combined SWMU 9 area. Remediation approaches to mitigate the landfill gas exposure risks will be developed based on the results of the investigation.

The landfill gas investigation will be conducted in the landfill area adjacent to the buildings and structures that are designated to remain in place. The investigation will include collecting a soil gas sample from depths that are above the groundwater table and below the soil cover at an approximate 50 feet on center. The soil gas samples will be analyzed using a flame ionization detector (FID) with and without corrections for methane. On the basis of the soil gas results, an assessment of potential for landfill gas generation and exposure risks to the landfill gas will be developed.

In the event the presence of landfill gas at Combined SWMU 9 requires venting, a passive venting system will be developed to intercept and vent the landfill gas in order to prevent exposure to the occupants/users of buildings and structures located on or near the landfill. The passive venting may include a slotted screen polyvinyl chloride (PVC) pipe installed below the soil cover and above the groundwater table to collect and convey the landfill gas above ground. The slotted screen pipe would be connected to a solid PVC pipe. A wind-driven turbine may be also be installed at the end of the solid PVC pipe to enhance the venting capability, if necessary. A schematic of a typical passive landfill gas vent system is shown on Figure 5-2.

For purposes of cost estimation, passive venting is assumed to be required and a total of 30 vents will be installed at 100 feet on center.

5.4 Land Use Controls and Long-Term Monitoring

The LTM for Combined SWMU 9 includes the activities and procedures to operate, monitor, and maintain the integrity and continued performance of the implemented remedy in conformance with the remedial objectives. The LTM will include O&M activities and performance verification sampling and monitoring activities, including the following:

- Implementing and maintaining the LUCs,
- Maintaining and monitoring the groundwater monitoring system, and

- Maintaining the integrity and effectiveness of the landfill cover, including making repairs to the cover, as necessary, to correct the effects of settling, subsidence, erosion, or other events.

The results of the monitoring activities will be evaluated to determine the need for additional CAs to address residual risks, if any, associated with the site.

5.4.1 Land Use Controls

The LUCs will be implemented to limit the future use of the site to control or eliminate exposure pathways to COCs at the site and to ensure the integrity and effectiveness of the presumptive remedy. With regard to real property, LUC refers to any restriction or control that limits the use of, and/or exposure to, a portion of the property, including water resources, arising from the need to protect human health and the environment. The LUCs will be primarily regarded as a component of CA that applies technologies that reduce toxicity, mobility, volume, and mass of the source of contamination and not as a stand-alone CA.

The term LUCs encompasses "institutional controls," which are defined as real estate restrictions, deed notifications, governmental permitting, zoning laws and other "legal" restrictions to protect human health and the environment. Institutional controls are non-engineered mechanisms used for ensuring compliance with necessary land use limitations.

LUCs also include restrictions on access (access controls), whether achieved by means of engineered barriers (e.g., fence or concrete pad), affirmative measures to achieve the desired restrictions (e.g., night lighting of an area), and prohibitive directives (e.g., restrictions on certain types of wells for the duration of the CA).

Considered altogether, the LUCs for a facility will provide a tool for directing how the property should be used in order to maintain the level of protectiveness that one or more CAs were designed to achieve. Periodic inspections will be conducted to ensure the long-term integrity of the remedy and the effectiveness of the LUCs.

LUCs will implemented at the site for the following reasons:

- Restricting human contact with solid waste material and groundwater that may have been contaminated with organic and inorganic constituents,
- Restricting soil disturbance activities (e.g., construction activities), and
- Prohibiting residential development of the site.

The LUCs will be developed and implemented in accordance with the site-specific LUCIP agreed to by the Navy and SCDHEC. Quarterly visual inspections and reviews will be conducted for the purpose of verifying that all necessary LUCs have been implemented and are being properly maintained. An annual report will be prepared and forwarded to the SCDHEC, signed by the Navy, certifying the continued retention of all LUCs implemented in Combined SWMU 9. Additionally, the recommendation for implementing LUCs will be incorporated into the RCRA Part B Permit for the CNC.

5.4.2 Groundwater Monitoring

A groundwater monitoring network will be used at Combined SWMU 9 to evaluate the potential for COCs to migrate offsite into surface water bodies or within an aquifer in a manner that may present unacceptable risks to human health and the environment. SCDHEC and CH2M-Jones have developed a list of wells to be sampled and analyses to be performed at Combined SWMU 9 as part of the sitewide groundwater monitoring program. The monitoring network for Combined SWMU 9 is presented in the September 2002 *Groundwater Monitoring and Well Inspection Work Plan* (CH2M-Jones, 2002a). The monitoring network consists of 20 wells, with 14 monitoring the shallow groundwater and 6 monitoring the deep groundwater, as shown on Figure 5-3. Five of the monitoring wells (H009GW005, H009GW05D, H009GW008, H009GW08D, and G706GW001) are located hydraulically upgradient of SWMU 9. The remaining 14 wells are located in the downgradient portion of the groundwater flow direction. Groundwater samples will be collected from the wells quarterly for the first year and analyzed for VOCs, SVOCs, and metals. If trends show relatively little change, then the sampling frequency may be changed to once a year, due to the relatively slow groundwater migration rate, and the analytical list may be focused to specific constituents. The locations of the monitoring network wells are presented on Figure 5-3.

5.4.2.1 Groundwater Monitoring Well Installation

The proposed monitoring network for Combined SWMU 9 consists of the existing wells and the newly installed wells. The new monitoring wells were installed in accordance with the Work Plan (CH2M-Jones, 2002a). The groundwater monitoring network shown on Figure 5-3 is complete. Post-RFI monitoring was initiated at Combined SWMU 9 in 2002 in accordance with the approved Work Plan.

5.4.2.2 Groundwater Sampling

To verify the effectiveness of the remedy, a monitoring program has been established as described in Work Plan (CH2M-Jones, 2002a). The sampling activities will be conducted in accordance with the sampling procedures and frequencies described in the plan.

5.4.2.3 Groundwater Data Evaluation

Since groundwater located within the landfill footprint is not used and will not be used in the future as a source of drinking water, offsite releases and consequential exposures are the primary exposure points of interest. Therefore, groundwater protection criteria are those that are established based on surface water exposure end points of interest.

Since Shipyard Creek is brackish water, there is no potable use of the surface water within the potential groundwater release areas in the immediate offsite areas. The small size of the Shipyard Creek in the immediate downgradient areas and inaccessibility precludes, and no fishing has been observed at the site.

If the future monitoring events indicate that the groundwater contamination in the perimeter monitoring wells is statistically significant and exceeds the MCLs, the groundwater data and site conditions will be evaluated for potential CAs. The groundwater data evaluation may include a statistical assessment, comparing background data from the three background wells using analysis of variance (ANOVA) or similar techniques. If the groundwater data evaluation indicates statistically significant exceedances, the groundwater data and site exposure conditions may be assessed to review if certain alternate concentration levels (ACLs) in place of MCLs are more appropriate to ensure the protection of human health and the environment at Combined SWMU 9.

ACLs may be calculated as target concentrations for the monitoring wells based on the dilution attenuation likely to be achieved while reaching exposure points and the target concentration at the exposure point (e.g., AWQC organisms only). These ACLs will also include protection of aquatic life, if such values are more conservative than protection of human health-based AWQC.

5.4.3 Site Inspection and Maintenance

Following construction, routine visual inspections of the landfill cover, LUCs, and monitoring points will be performed. Subsequent inspections will be conducted quarterly for the first year and semi-annually thereafter. Inspections will include looking for signs of settling, disturbance of soil cover, and the presence of exposed waste material. Based on the inspections, necessary repairs will be performed, including soil cover regrading and erosion repair, to ensure that the corrective measure remains effective and in place. Routine inspections will check for the following:

- Site access and security measures are intact,
- Site signs, including warning signs, are in good condition,
- Groundwater and sediment monitoring points are accessible and clearly identified,
- Signs of distressed or dead vegetative cover,
- Presence of animal burrows in the cover area, and
- Evidence of differential settlement at the site.

5.4.3.1 Erosion and Sediment Control Monitoring

Inspection activities for soil erosion and sediment transport due to stormwater run-on and run-off will include routine inspections for the following:

- Significant cracks in sloped areas,
- Evidence of sediment transport at or beyond the site boundary,
- Evidence of significant vegetative cover loss,
- Obstructed drainage ditches/pipes, and
- Inoperable erosion/sediment control devices.

5.4.3.2 Cover Maintenance and Repair

Routine maintenance activities and repair procedures will be necessary to maintain the integrity of the cover to ensure the protection of human health and the environment. Repair procedures may also be necessary to address the potential increase in human and ecological risks, due to potential or actual releases of hazardous constituents, in the event the cover integrity is threatened as a result of utility or other construction activities.

These maintenance activities and repair procedures will be part of the O&M program for the site and are expected to include the following:

- Installation of subsurface utilities or excavation of any type for any purpose,
- Construction of a below ground structure, including, but not limited to, foundation walls, wells for drinking water, irrigation, or other domestic purposes,
- Construction and surface activities that may transmit stresses to landfill wastes,

- Installation and/or storage of chemicals, waste chemical products, or equipment with the potential for chemical leakage,
- Storage of goods for human or animal consumption, and
- Signs restricting access.

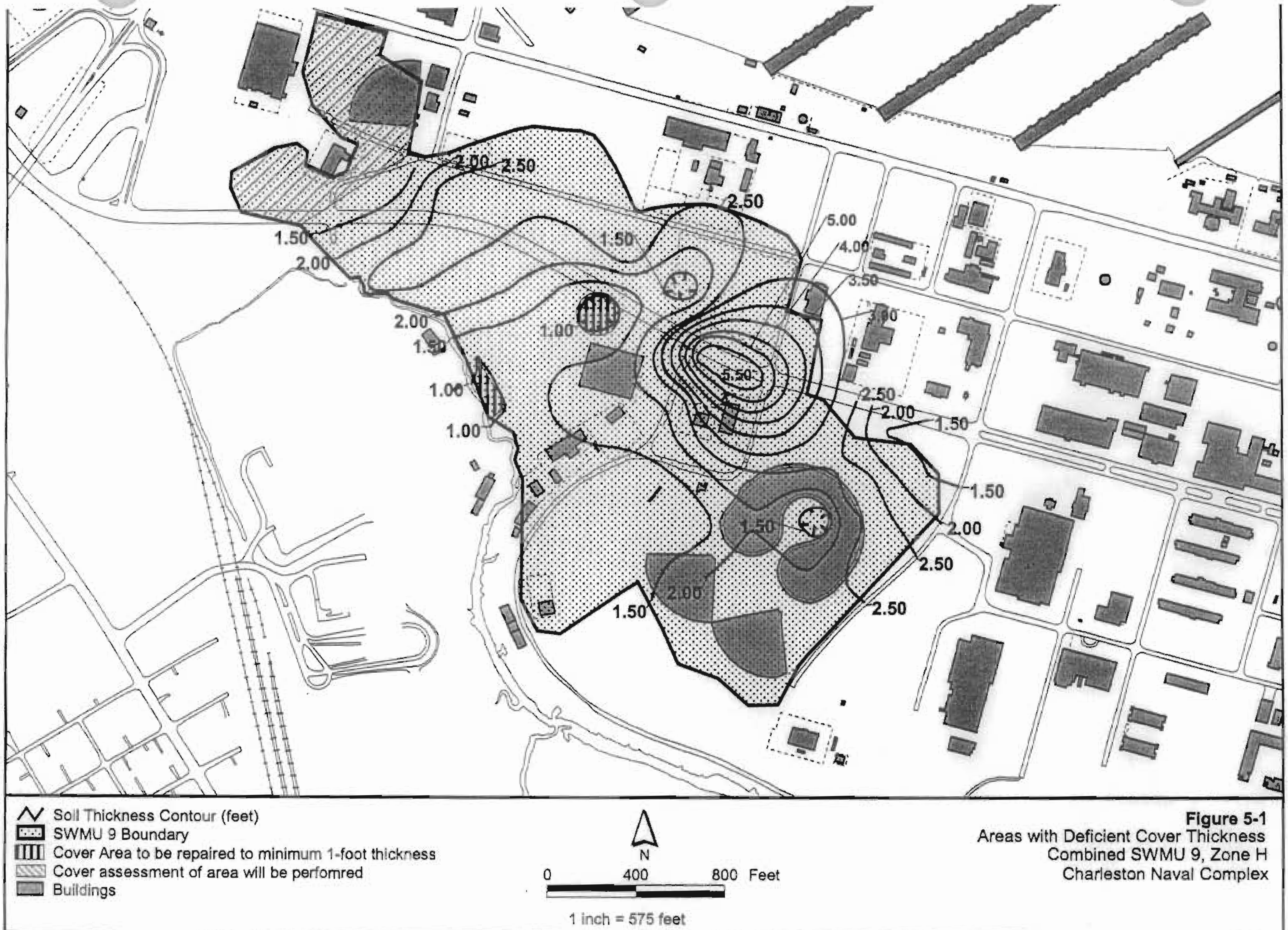

Figure 5-1
Areas with Deficient Cover Thickness
Combined SWMU 9, Zone H
Charleston Naval Complex

File Path: C:\18gis\Projects\Zone_H\Swmu_9\Apr\swmu9_v2.apr, Date: 20 Dec 2002 16:18, User: DBEVERLY, EGIS: Charleston Naval Complex - Figure 2-11 Land Fill Soil Cover Thickness

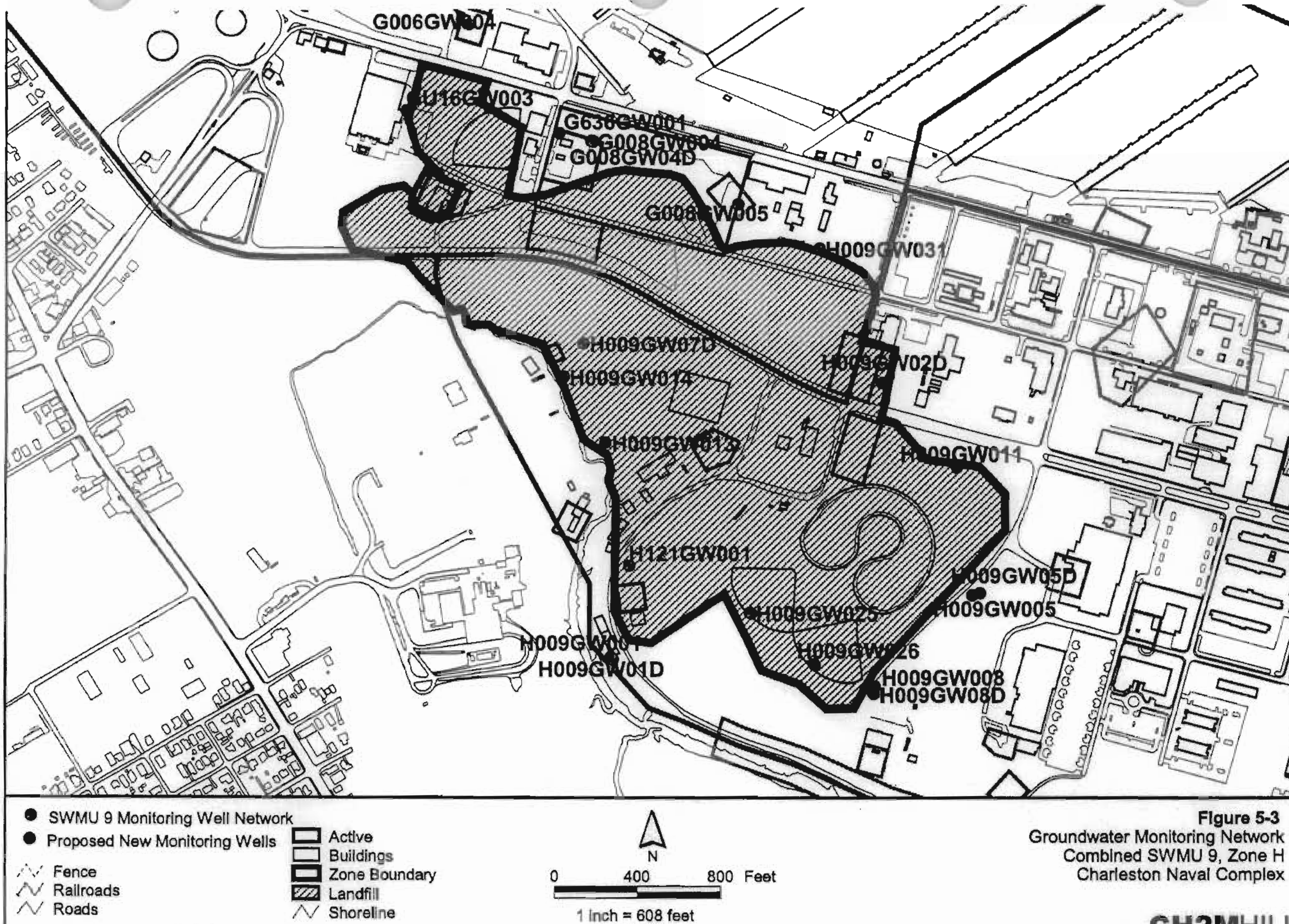

Figure 5-3
Groundwater Monitoring Network
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

File Path: c:\18gis\cnc\cnc-egis.apr, Date: 25 Feb 2004 14:46, User: SNAIK1, EGIS: Charleston Naval Complex - Figure 5-3 Groundwater Monitoring Network

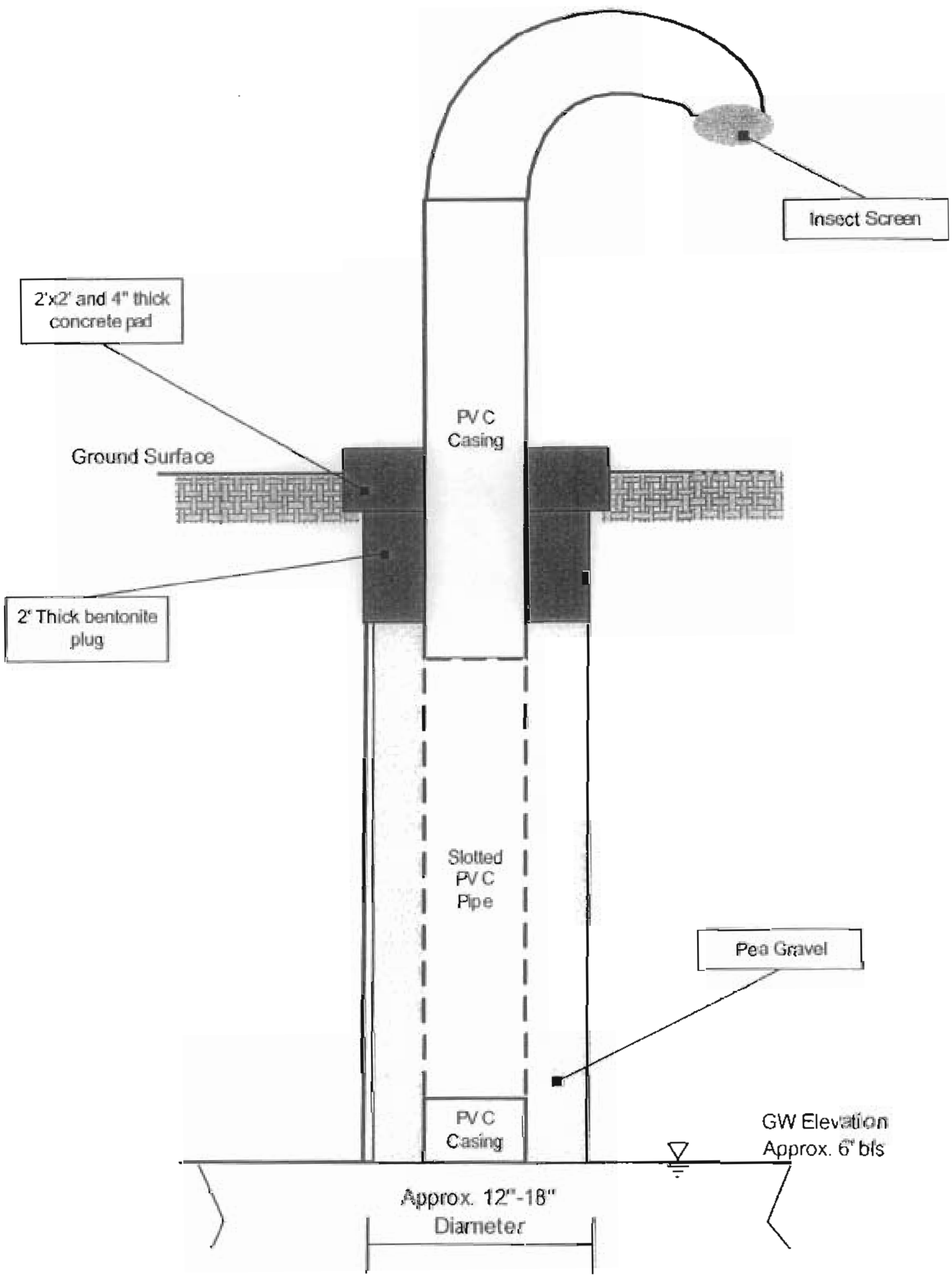

Figure 5-2
Typical Passive Landfill Gas Vent System
Combined SWMU 9, Zone H
Charleston Naval Complex

CH2MHILL

Section 6.0

6.0 References

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Appendix A

Appendix A

Determination of the Northern Boundary of Combined SWMU 9 Landfill

The Environmental Detachment Charleston (DET) performed an additional interim measure (IM) for intrusive geophysical investigation in January 1999 (see the *Geophysical/Intrusive Survey of Combined SWMU 9 Closed Landfill* report, which is included in this appendix). In addition, an aerial topographic survey of the landfill area was completed in April 1999 to verify the landfill's northern boundary. An evaluation of historical land disturbances, as suggested by the aerial photographs taken between 1944 and 1960, was also made.

The DET excavated a total of 116 test pits, each approximately 6 feet long, 2 feet wide, and 1 to 7 feet deep. Figure 1-2, which has been generated based on information in the *Geophysical/Intrusive Survey of Combined SWMU 9 Closed Landfill* report, shows the locations of the test pits.

The initial test pits were staked out approximately every 50 feet along the existing estimated northern boundary of the landfill. The northern boundary at the time of the DET IM investigation extended from the north side of Bainbridge Avenue near Building 1785 to the north side of Bainbridge Avenue near Building 246. Following excavation, each test pit was visually inspected for the presence of landfill debris, which, if observed, necessitated excavation of another test pit approximately 25 to 100 feet outward from the initial test pit. Likewise, if no landfill debris was observed at an initial test pit, a subsequent test pit was excavated inward from the initial location. This process continued until the actual extent of the landfill boundary in the area north of Bainbridge Avenue was determined.

Following visual inspection and logging of the unearthed material, each test pit was backfilled with the same material that was removed during excavation, then graded to appear as undisturbed as practical. Table A of the *Geophysical/Intrusive Survey of Combined SWMU 9 Closed Landfill* report shows the findings of each test pit from the DET IM.

The test pit findings were re-evaluated during this CMS effort and several areas that were originally part of the landfill boundary proposed by EnSafe Inc.'s Draft SWMU 9 CMS Report (which was never submitted to the South Carolina Department of Health and Environmental Control) were excluded. These exclusions were based on the absence of landfill-type debris material in the test pit excavations. The area primarily excluded is a partial area in the northern portion of SWMU 8 in Zone G.

The DET performed an IM at SWMU 8 for the removal and disposal of oil-contaminated soil and sludge. According to the SWMU 8 DET IM Report (DET, 1999), during the contaminated soil excavation, scrap metal, timbers, glass and other debris were excavated down to the water table and disposed off site. This indicates that even though landfill-type debris was found within the SWMU 8 footprint, the IM DET may have removed this material. However, the southern portion of SWMU 8 is included in the Combined SWMU 9 boundary, based on the presence of landfill-type debris in the test pits dug during the DET IM. There is no evidence of the presence of landfill material in the remaining areas of SWMU 8, which are undergoing LUCs, as indicated in the CMS Report for SWMU 8, Revision 0 (CH2M-Jones, 2003).

The proposed landfill boundary also includes the footprint of AOC 706 in Zone G. The test pits to the west of AOC 706 (Test Pit Nos. 109, 110, 113 through 116) did not indicate the presence of landfill-type debris or material foreign to the area. However the test pits east of AOC 706 (Test Pit Nos. 52 through 58) showed the presence of wood, broken concrete, drain tile, etc.). It is possible that subsurface soils in the interior areas of AOC 706 could contain similar debris. Therefore, AOC 706 has been included in the footprint of the landfill.

The Combined SWMU 9 boundary considered in this CMS Report includes the eastern part of the landfill boundary beginning near Test Pit No. 1 near the intersection of Halsey Street and Bainbridge Avenue, and following Holland Street from the intersection of Bainbridge Ave and Holland Street, the southern boundary along Shipyard Creek and the western boundary ending at Test Pit No. 102.

On the basis of the above evaluation, the northern boundary of the Combined SWMU 9 landfill boundary is established as shown in Figure 2-1 in the main body of this Revision 1 CMS Report. Figure 1-2 included in this appendix is a copy from the DET IM Report and is included only as a reference to indicate the location of the test pits excavated by the Navy DET as part of the determination of the northern boundary of the landfill. The northern boundary shown in Figure 1-2 was estimated at the conclusion of the DET IM in 1999, but the current northern boundary as agreed to by the CNC BCT is reflected in Figure 1-2 of the main body of this Revision 1 CMS Report.

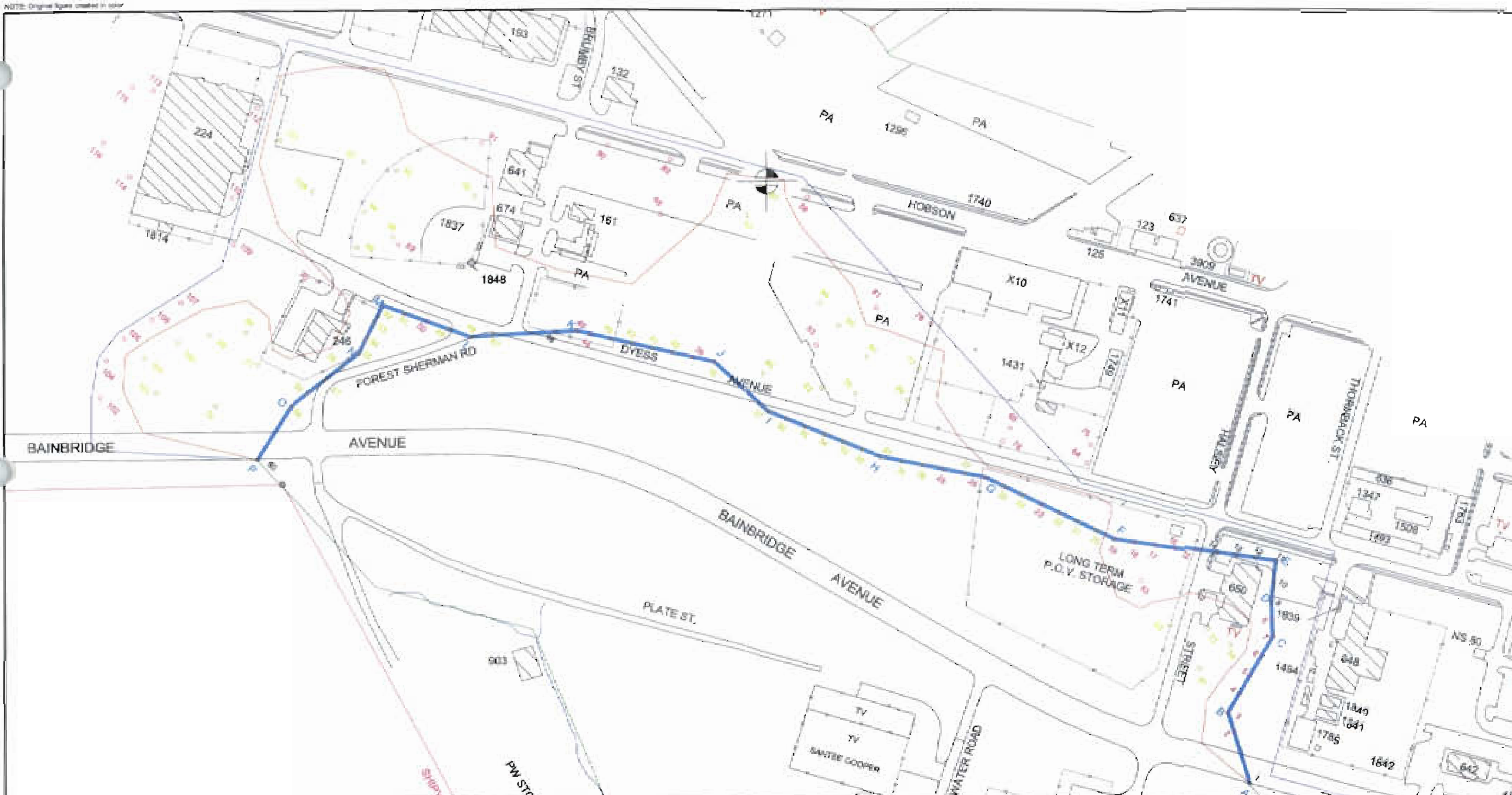
References

Supervisor of Shipbuilding, Conversion and Repair, United States Navy, Environmental Detachment Charleston (DET). *Completion Report, Interim Measure for SWMU 8, Naval Base Charleston, SC.* November 19, 1999.

Table A-1 Available Historical and Recent Groundwater Elevations of Select Groundwater Monitoring Wells
Combined SWMU 9, Zone H, Charleston Naval Complex

STATION	ELEVATION				
Date	April-94	April-95	September-95	March-96	June-02
H009GW003	5.92	3.94	5.86	5.71	4.87
H009GW011	7.08	4.64	7.78	6.52	5.30
H009GW013	3.89	2.84	4.01	3.39	NS
H009GW014	3.50	2.81	4.25	3.59	3.85
H009GW016	Not installed in Apr-94	3.70	3.66	8.44	4.03
H009GW017	Not installed in Apr-94	3.29	3.54	3.18	3.83
H009GW018	Not installed in Apr-94	2.63	4.02	3.48	0.22
H009GW019	Not installed in Apr-94	3.59	4.60	4.34	4.26
H009GW026	Not installed in Apr-94	Not installed in Apr-95	Not installed in Sept-95	6.62	5.51
H009GW02D	5.58	5.93	5.96	5.92	5.88
H009GW03D	6.67	9.88	9.48	9.42	9.60
H121GW001	Not installed in Apr-94	5.47	5.46	5.40	3.55

NOTE: Original figure created in color



103 Test pits with foreign material found

103 Test pits with no foreign material found

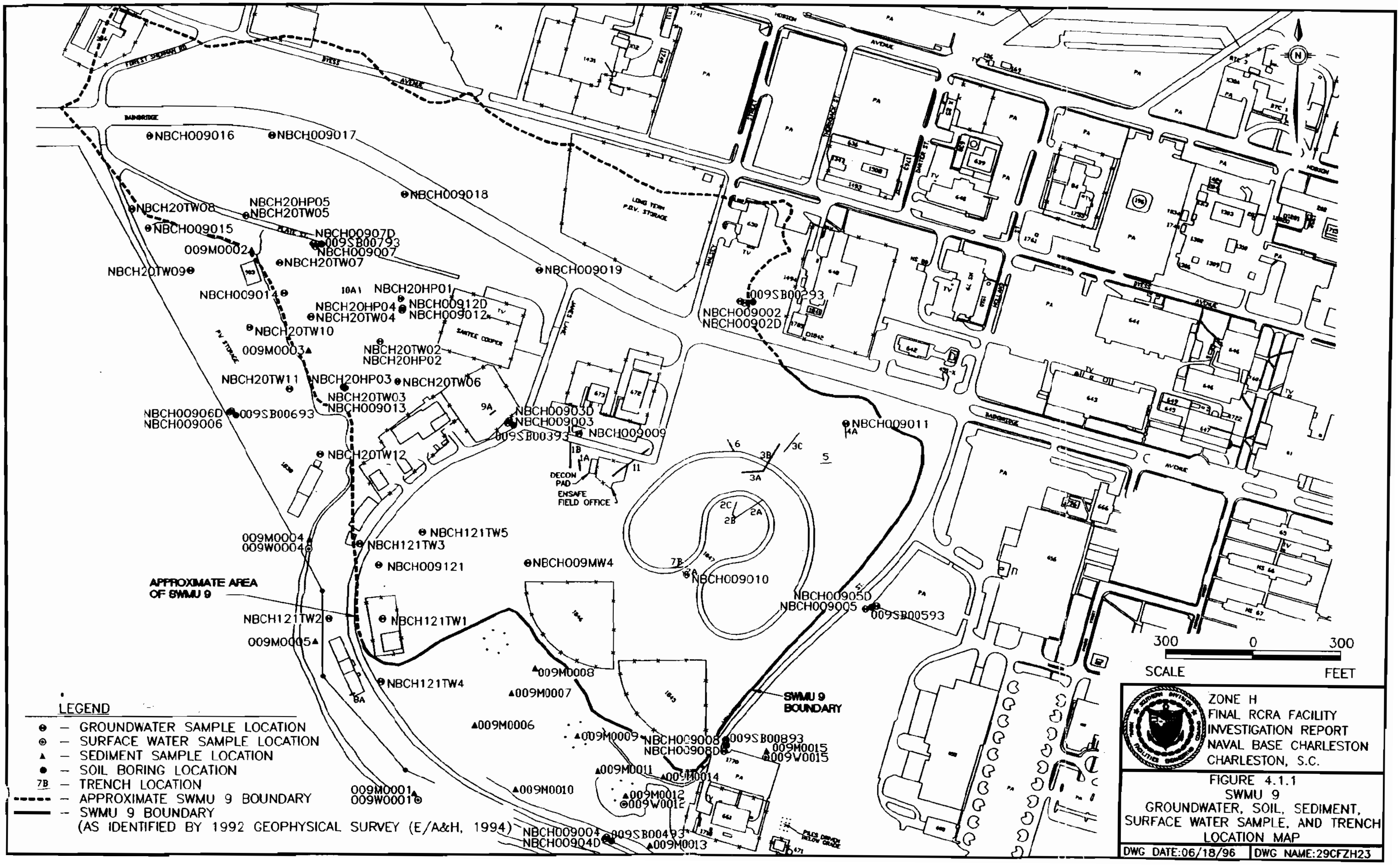
N

0 90 180 Feet

1 inch = 225 feet

Figure 1-2
Northern Landfill Boundary Investigation
SWMU 9, Zone H
Charleston Naval Complex

Source: EnSafe, Inc. (1999)


NBCH009016
NBCH009017
NBCH009018
NBCH20TW08
NBCH20HP05
NBCH20TW05
NBCH009015
NBCH00907D
009SB00793
NBCH009007
009M0002
NBCH20TW07
NBCH20TW09
NBCH009019
NBCH009014
10A1
NBCH20HP01
NBCH20HP04
NBCH00912D
NBCH20TW04
NBCH009012
NBCH20TW10
009M0003
NBCH20TW02
NBCH20HP02
NBCH20TW11
NBCH20HP03
NBCH20TW06
NBCH20TW03
NBCH009013
NBCH00906D
NBCH009006
009SB00693
NBCH00903D
NBCH009003
009SB00393
NBCH009009
009SB00293
NBCH009002
NBCH00902D
NBCH009011
NBCH20TW12
DECON PAD
ENSAFE FIELD OFFICE
009M0004
009W0004
NBCH121TW5
NBCH121TW3
NBCH009121
NBCH009MW4
NBCH009010
APPROXIMATE AREA OF SWMU 9
NBCH121TW2
NBCH121TW1
NBCH00905D
NBCH009005
009SB00593
009M0005
009M0008
NBCH121TW4
009M0007
SWMU 9 BOUNDARY
009M0006
009M0009
NBCH009008
NBCH00908D
009SB00893
009M0015
009W0015
009M0011
009M0014
009M0001
009W0001
009M0010
009M0012
009W0012
NBCH009004
NBCH00904D
009SB00493
009M0013
300 0 300
SCALE FEET
LEGEND
— GROUNDWATER SAMPLE LOCATION
— SURFACE WATER SAMPLE LOCATION
— SEDIMENT SAMPLE LOCATION
— SOIL BORING LOCATION
7B — TRENCH LOCATION
— APPROXIMATE SWMU 9 BOUNDARY
— SWMU 9 BOUNDARY
(AS IDENTIFIED BY 1992 GEOPHYSICAL SURVEY (E/A&H, 1994))
ZONE H
FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 4.1.1
SWMU 9
GROUNDWATER, SOIL, SEDIMENT,
SURFACE WATER SAMPLE, AND TRENCH
LOCATION MAP
DWG DATE:06/18/96
DWG NAME:29CFZH23

FINAL REPORT

GEOPHYSICAL/INTRUSIVE SURVEY
COMBINED SWMU 9 CLOSED LANDFILL
NAVAL BASE CHARLESTON
CHARLESTON, SC

Prepared for:

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON SC

Prepared by:

Supervisor of Shipbuilding, Conversion and Repair,
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Environmental Detachment Charleston, S.C.
1899 North Hobson Ave.
North Charleston, SC 29405-2106

January 22, 1999

FINAL REPORT

Geophysical/Intrusive Survey for Combined SWMU 9 Closed Landfill Charleston Naval Complex, Charleston, SC

Engineering Branch Head: [signature] **Date:** 1-25-99

Prepared By: [signature] **Date:** 1-25-99

REPORT GENERATED BY:
ENVIRONMENTAL DETACHMENT CHARLESTON
1899 NORTH HOBSON AVENUE
NORTH CHARLESTON, SC 29405

1. BACKGROUND

In 1992, a geophysical and soil-gas survey was performed at the Combined Solid Waste Management Unit (SWMU) 9 landfill site to delineate the landfill boundary and identify containers and/or contaminant plumes present at the site. Following these surveys, exploratory trenches were excavated to identify the source of geophysical anomalies and soil-gas hot spots. The excavations allowed visual determination of the landfill contents as well as the extent of the landfill boundary at selected locations. However, the trenching was not conclusive enough to establish the entire perimeter boundary, particularly along the northern side of the landfill. According to the Zone H Corrective Measures Study (CMS) Work Plan dated 26 November 1997, completion of these trenches or "test pits" was necessary to confirm the results of the 1992 geophysical survey and to ascertain the actual landfill boundary in those areas where the boundary was only estimated.

The Zone H CMS Work Plan also suggests source containment as a presumptive remedy for this landfill which involves containment of the landfill mass via an earthen cap. To provide a baseline for construction of a landfill cap, for enhancing drainage and to prevent surface water infiltration, a topographic map of the Combined SWMU 9 site is also necessary.

On 29 April 1998 the Environmental Detachment Charleston (DET) submitted Project Execution Packages (PEP's) for conducting geophysical/intrusive and topographic surveys of the Combined SWMU 9 site. As expected, the results of the geophysical survey will influence the extent of the topographic survey. It was for this reason that the geophysical survey was conducted first.

2. SITE DESCRIPTION

Combined SWMU 9, a closed landfill located at the southern end of NAVBASE, is generally bounded by Shipyard Creek to the southwest, Bainbridge Avenue to the northeast, and Holland Street to the southeast. Several associated SWMU and Area of Concern (AOC) sites (SWMUs 19, 20 & 121 and AOCs 649, 650, 651 & 654) are located within the SWMU 9 estimated perimeter and thus the term Combined SWMU 9. Although Combined SWMU 9 was a military-use landfill used for industrial and domestic solid waste from the 1930s until the early 1970s, Combined SWMU 9 is considered a low-level risk municipal-type landfill because it contains primarily municipal-type wastes. Samples collected from SWMU 9 and associated sites during the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) process identified several Constituents of Potential Concern (COPCs) including pesticides, herbicides, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, petroleum hydrocarbons and dioxins.

3. GEOPHYSICAL/INTRUSIVE SURVEY OBJECTIVES

The primary objective of this investigation was to conduct an intrusive geophysical survey in combination with aerial photo interpretation to identify the extent of the northern boundary of the Combined SWMU 9 landfill at NAVBASE Charleston.

4. PROJECT EXECUTION

In addition to researching facility files, aerial photographs, RFI data and Intrerim Measure documentation, intrusive surveys were conducted to determine the extent of the northern portion of the landfill boundary. These intrusive surveys consisted of numerous small excavations called test pits. All test pits were excavated using a backhoe and were approximately 6 feet long by 2 feet wide and from 1 to 7 feet deep.

The initial test pits were staked out along the existing estimated northern boundary (from the north side of Bainbridge Avenue near Building 1785 to the north side of Bainbridge Avenue near Building 246) and were spaced approximately every 50 feet. The location for all initial test pits was determined by surveying to existing estimated boundary coordinates extracted from the state plane coordinate drawing for this area of NAVBASE. All surveying was performed using conventional surveying equipment including electronic theodolite with data collector, electronic distance meter (EDM) and reflector prism.

Following excavation, each test pit was visually inspected for the presence of landfill debris which, if observed, necessitated excavation of another test pit approximately 25 to 100 feet outward from the initial test pit. Likewise, if no landfill debris was observed at an initial test pit, a subsequent test pit was excavated inward of the initial location. This process continued until the actual extent of the landfill boundary in the area north of Bainbridge Avenue was determined. Following visual inspection, each test pit was backfilled with the same material that was removed during excavation then groomed to appear as undisturbed as practical.

Figure 1 of this report illustrates the changes to the northern portion of the landfill boundary based on the results of a sufficient number of test pits. Using this new northern boundary, the total area of Combined SWMU 9 is now estimated to be approximately 99.01 acres, increased from approximately 84.67 acres estimated prior to the geophysical survey. **Table A** of this report summarizes the intrusive survey results of all 116 excavated test pits. It should be noted that **Table A** reflects varying excavation depths. This is due to the fact that excavation was generally terminated at the water table or at the positive presence of landfill debris. Also, in locations where landfill debris was not present, excavation was generally deeper to ensure against premature termination. A total of 56 test pits were photographed prior to backfilling to document the types of landfill debris observed during excavation. Based on the best representation of the types of soil and landfill debris observed during excavation, several of these photographs are included on pages 12 through 17 of this report.

TABLE A
SWMU 9 GEOPHYSICAL/INTRUSIVE SURVEY
Investigation Results Summary for
SWMU 9 Test Pit Excavations in the Area North of Bainbridge Avenue
(Refer to Figure 1 for test pit locations)

Test Pit Location	Excavation Date	Excavation Depth (Ft.)	Foreign Material	Remarks
1	-	-	-	Not excavated, located south of Bainbridge Avenue
Refer to **Figure 1** and note the distance between test pits #1 & #2. This was necessary to avoid excavation of the Bainbridge Avenue roadway surface and the road build-up area.				
2	08/12/98	4	None	
3	08/12/98	4	None	
4	08/12/98	5.5	None	
5	08/12/98	4	None	
6	08/12/98	4	None	
7	08/12/98	4	None	
8	08/12/98	4	None	
9	-	-	-	Not excavated, located in asphalt parking lot
10	-	-	-	Not excavated, located in asphalt parking lot
11	-	-	-	Not excavated, located in asphalt parking lot
12	-	-	-	Not excavated, located in asphalt parking lot
13	-	-	-	Not excavated, located in asphalt parking lot
14	-	-	-	Not excavated, located in asphalt parking lot
15	08/24/98	5	None	
16	08/24/98	5	None	
17	08/24/98	5.5	None	
18	08/24/98	4.5	None	
19	08/24/98	7	None	

TABLE A
SWMU 9 GEOPHYSICAL/INTRUSIVE SURVEY
Investigation Results Summary for
SWMU 9 Test Pit Excavations in the Area North of Bainbridge Avenue
(Refer to Figure 1 for test pit locations)

Test Pit Location	Excavation Date	Excavation Depth (Ft.)	Foreign Material	Remarks
20	08/24/98	6	Sheet metal, wire cable	
21	08/24/98	4.5	Metal, glass, rags, wire	
22	08/24/98	See Remarks	See Remarks	Large corrugated steel plate buried approx. 8" deep prevented excavation
23	08/24/98	6	None	
24	08/24/98	6	Wire, metal strapping	
25	08/24/98	5	Wood, wire, sheet metal, broken concrete	
26	08/25/98	5.5	None	Strong odor of fuel oil
27	08/25/98	5	Broken bricks, broken concrete	Light odor of fuel oil
28	08/25/98	5	None	Standing water at 2 feet
29	08/25/98	5	Wood, plastic	
30	08/25/98	5	One 6ft. 2 x 6 wood board	
31	08/25/98	4.5	Traces of plastic	
32	08/27/98	4	Broken asphalt, broken concrete	
33	08/27/98	3.5	Rags, wire, wood, pipe, bricks, metal	Odor of fuel oil
34	08/27/98	3.5	Bricks, copper tubing, rope, metal, wire, wood, plastic	
35	08/27/98	3	Concrete blocks, broken concrete, re-bar, wood, wire	
36	08/27/98	3	Rags, plastic, metal, broken asphalt, broken concrete, bricks	
37	08/27/98	3	Rags, plastic, metal, broken asphalt, broken concrete, bricks	
Refer to Figure 1 and note the distance between test pits #37 & #38. This was necessary to avoid excavation of the Dyess Avenue roadway surface and the road build-up area.				
38	08/20/98	5	Household trash	

TABLE A
SWMU 9 GEOPHYSICAL/INTRUSIVE SURVEY
Investigation Results Summary for
SWMU 9 Test Pit Excavations in the Area North of Bainbridge Avenue
(Refer to Figure 1 for test pit locations)

Test Pit Location	Excavation Date	Excavation Depth (Ft.)	Foreign Material	Remarks
39	08/20/98	7	None	
40	08/20/98	4	Wood, paper, rubber	
41	08/20/98	4	Wood, metal strapping, paper, plastic	
42	08/20/98	4	Wood, broken concrete	
43	08/20/98	4	Wood, broken concrete, plastic, re-bar	
44	08/20/98	5	None	
45	08/20/98	5	None	
46	-	-	-	Not excavated, located in wetland ditch
Refer to Figure 1 and note the distance between test pits #46 & #47. This was necessary to avoid excavation of the Dyess Avenue roadway surface and the road build-up area.				
47	08/28/98	4	Wood, plastic, broken concrete	
48	08/28/98	4.5	Pieces of large creosoted timbers 10-12" diameter	
49	08/28/98	4.5	Broken concrete, glass, wire	
50	08/28/98	6	None	
51	08/28/98	1.5	Glass, wood, steel scrap, sheet metal, strapping	
52	08/28/98	1.5	Wood, paper, sheet metal, steel, broken asphalt	
53	08/28/98	3	Wood, strapping, broken concrete, wire	
54	08/28/98	2	Wood, nails, metal conduit, brick, wire	
55	08/28/98	6	Wood, copper cable, sheet metal, paper	
56	08/28/98	4	Wood, broken concrete, broken drain tile, scrap metal, strapping	

TABLE A
SWMU 9 GEOPHYSICAL/INTRUSIVE SURVEY
Investigation Results Summary for
SWMU 9 Test Pit Excavations in the Area North of Bainbridge Avenue
(Refer to Figure 1 for test pit locations)

Test Pit Location	Excavation Date	Excavation Depth (Ft.)	Foreign Material	Remarks
57	08/28/98	3.5	Wood, broken concrete	
58	08/28/98	4	Wood, broken concrete, broken drain tile	
59	08/28/98	4	Wood, broken concrete, broken tile, pieces of creosoted timbers	
Refer to Figure 1 and note the distance between test pits #59 & #60. This was necessary to avoid excavation of the Bainbridge Avenue roadway surface and the road build-up area.				
60	-	-	-	Not excavated, located south of Bainbridge Avenue
61	09/25/98	3	Timbers, paper, brick	
62	09/25/98	4	Wood, brick, scrap metal, cloth, wire	
63	09/25/98	7	None	
64	09/25/98	5	None	
65	09/25/98	7	None	
66	09/25/98	7	Timbers, angle iron, broken concrete	Excavated thru asphalt, very strong fuel oil odor
67	09/25/98	6	Timbers, broken concrete	Excavated thru asphalt
68	09/25/98	4.5	None	
69	09/25/98	4	None	May be inconclusive. Large subsurface structure limited excavation to 4'
70	09/25/98	4	None*	*One small piece of glass and one small piece of wire
71	09/25/98	3.5	Broken concrete, broken tile, brick	
72	09/25/98	3.5.	Broken concrete, iron, plating, brick	
73	10/21/98	4	Wire, steel scrap, broken tile	
74	10/21/98	2.5	Wire, wood, scrap metal, brick	
75	10/21/98	7	None	Layered soil

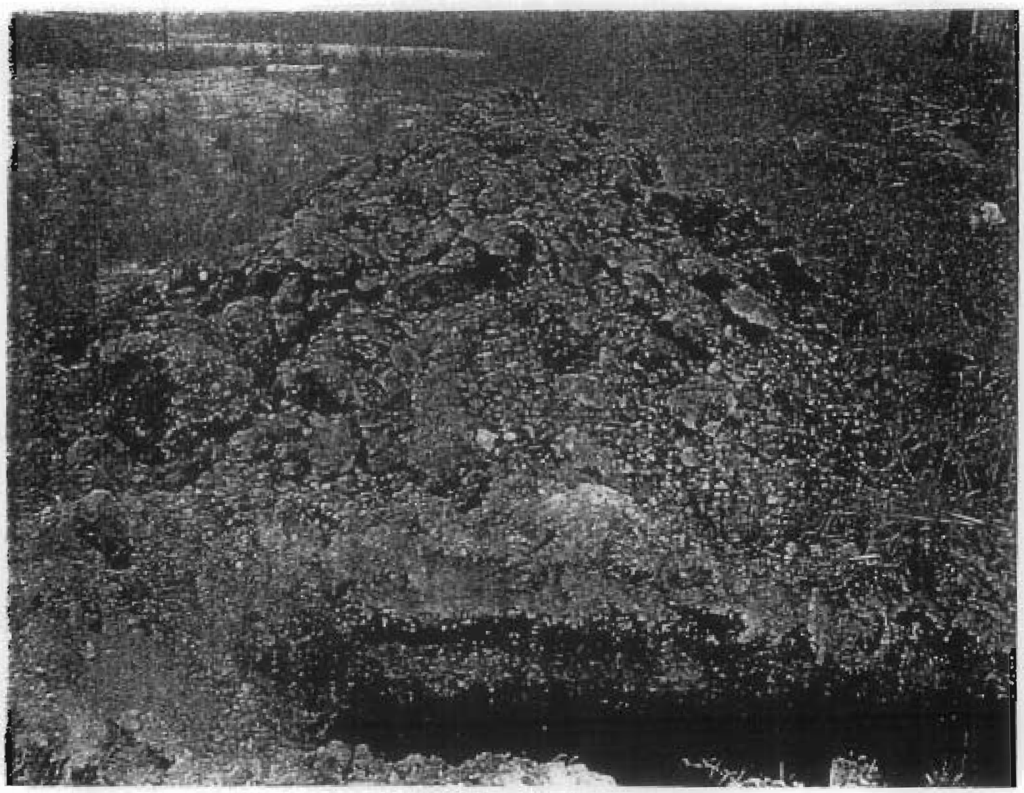
TABLE A
SWMU 9 GEOPHYSICAL/INTRUSIVE SURVEY
Investigation Results Summary for
SWMU 9 Test Pit Excavations in the Area North of Bainbridge Avenue
(Refer to Figure 1 for test pit locations)

Test Pit Location	Excavation Date	Excavation Depth (Ft.)	Foreign Material	Remarks
76	10/21/98	7	None	
77	10/21/98	7	One 5' timber, one piece copper wire	Excavated thru asphalt, very strong fuel oil odor
78	10/21/98	6	None	
79	10/21/98	7	Very small amounts of rubber, glass & metal	Strong fuel oil odor
80	10/21/98	5	Timbers, broken concrete	Strong fuel oil odor
81	10/21/98	6	None	
82	10/21/98	3	Wire, scrap metal, wood, brick, strapping	Free product fuel oil
83	10/21/98	6.5	None	Strong fuel oil odor
84	10/21/98	6	Timbers, one piece broken concrete	Strong fuel oil odor
85	10/21/98	5	One piece wire cable & small amounts of broken concrete	Strong fuel oil odor
86	10/21/98	2	Wood, plastic, metal, paper, bottles, broken concrete	
87	10/21/98	1	Glass, broken concrete, brick, scrap metal	
88	10/21/98	5	None	Layered soil
89	10/22/98	6	None	
90	10/22/98	6	None	
91	10/22/98	6	None	
92	10/22/98	5	Wood, scrap metal, broken concrete, wire	
93	10/22/98	1.5	Concrete, wire, scrap metal, plastic	
94	10/22/98	1.5	Concrete, wire, scrap metal	
95	10/22/98	3	Concrete, wire, scrap metal, brick, wood, rope	

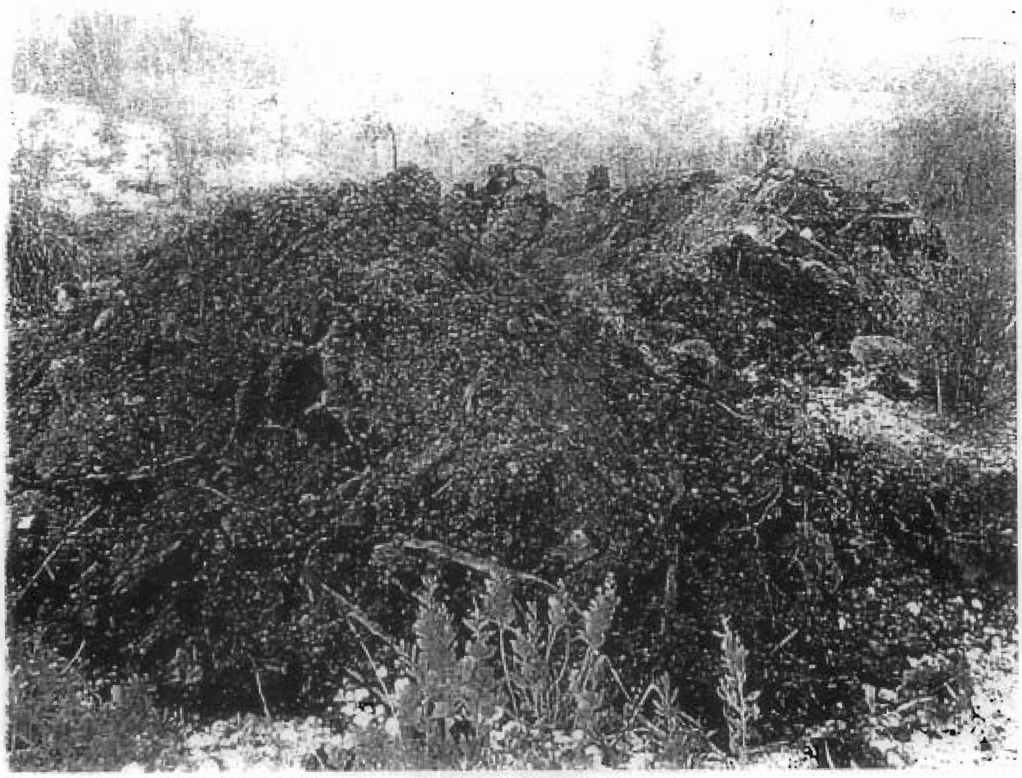
TABLE A
SWMU 9 GEOPHYSICAL/INTRUSIVE SURVEY
Investigation Results Summary for
SWMU 9 Test Pit Excavations in the Area North of Bainbridge Avenue
(Refer to **Figure 1** for test pit locations)

Test Pit Location	Excavation Date	Excavation Depth (Ft.)	Foreign Material	Remarks
96	10/22/98	4	scrap metal, brick, wood, glass	
97	10/22/98	1	Concrete, wire, scrap metal, brick, wood, glass, rubber, china	
98	10/22/98	1.5	Concrete, wire, wood, china	
99	10/22/98	6	Very small amounts of wood & plastic	
100	10/22/98	2.5	Scrap metal, china, wood, glass	
101	10/22/98	4	Scrap metal, plastic, tile, brick	
102	10/22/98	5	None	
103	10/22/98	5	Concrete, tile, brick, glass, metal, wood	
104	11/12/98	4.5	None*	*One small piece of broken concrete approx. 6" deep
105	11/12/98	5.5	None	
106	11/12/98	4.5	None	
107	11/12/98	5	None	
108	12/01/98	3	Wood, brick, concrete, plastic, wire, metal strapping, rubber	Odor of fuel oil
109	12/01/98	5	None	
110	12/01/98	5	None	
111	12/01/98	3	Scrap metal, china, glass, wire, rags, wood, bottles	
112	12/01/98	5	None	
113	12/01/98	6	None	
114	12/01/98	6	None	
115	12/01/98	7	None	
116	12/01/98	7	None	

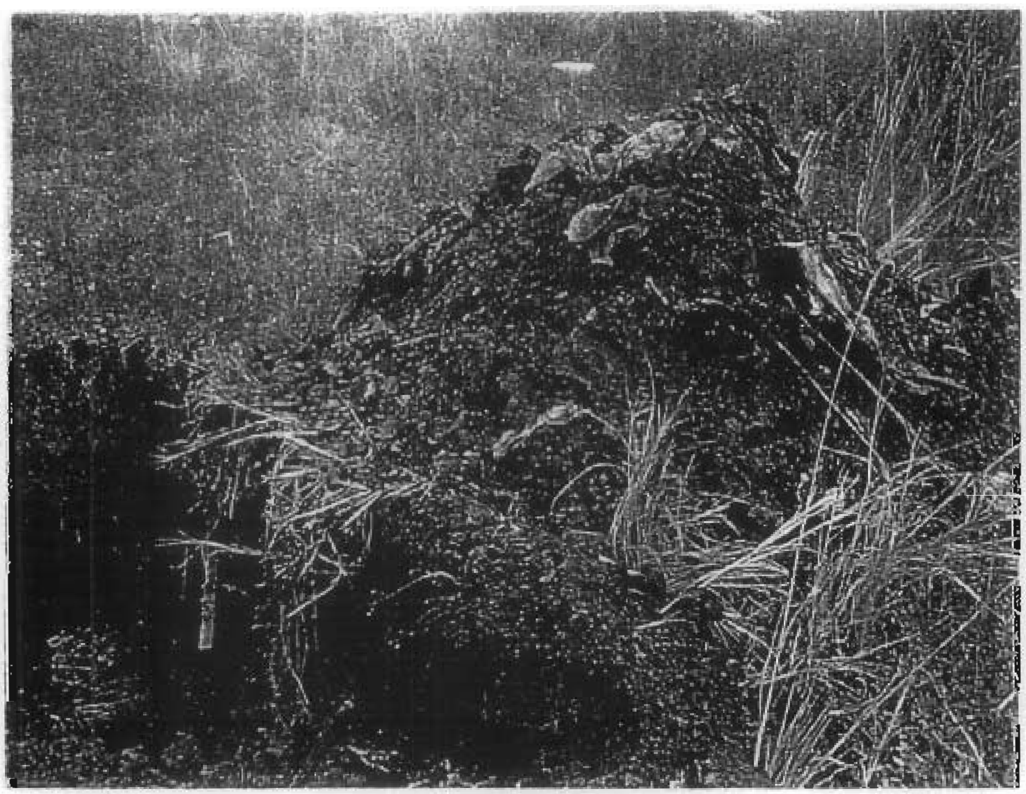
Test Pit #72



Test Pit #75



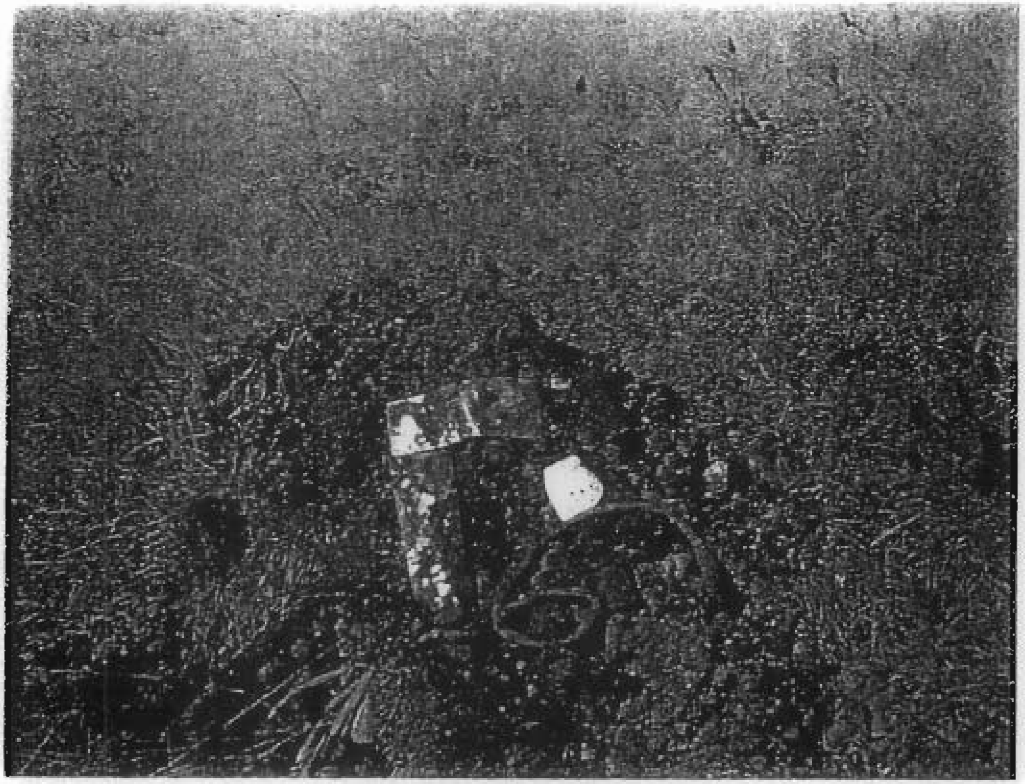
Test Pit #82



Test Pit #86

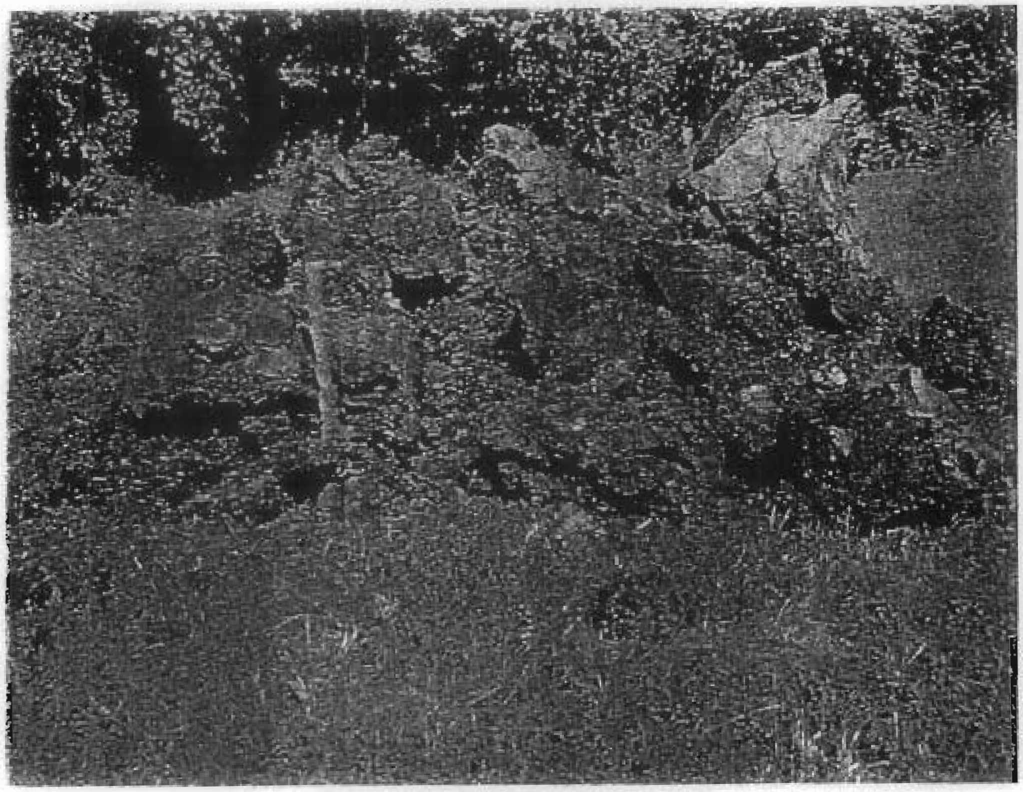
Test Pit #88

Test Pit #95



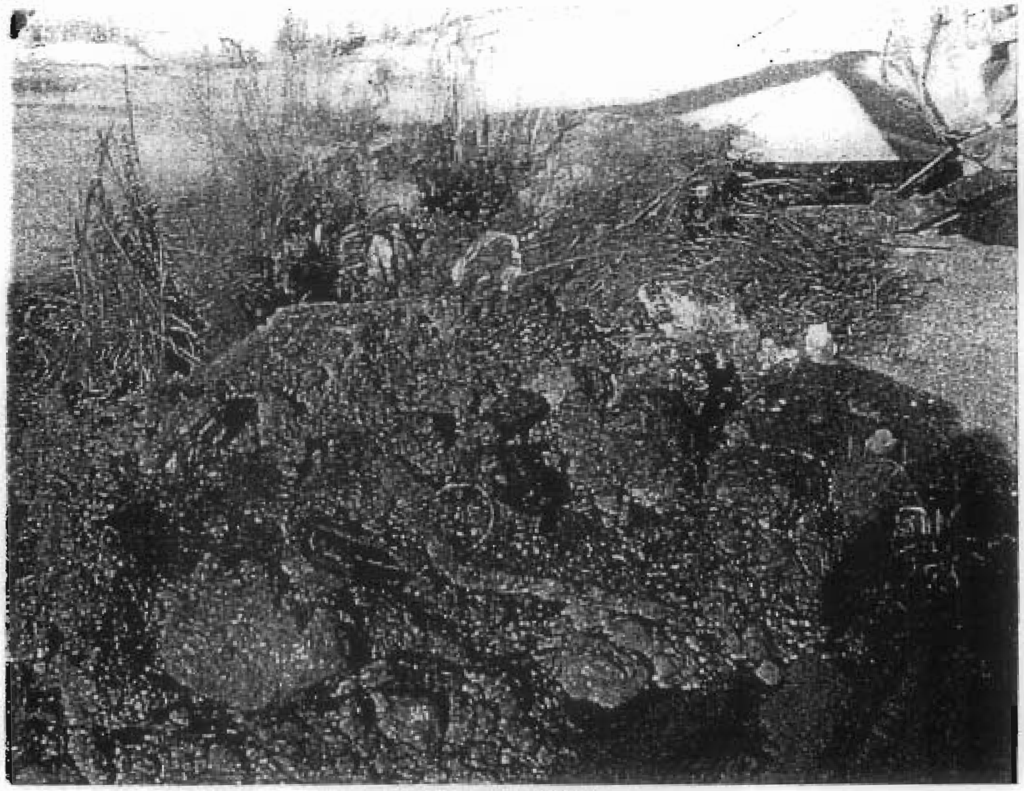
Test Pit #97

Test Pit #100

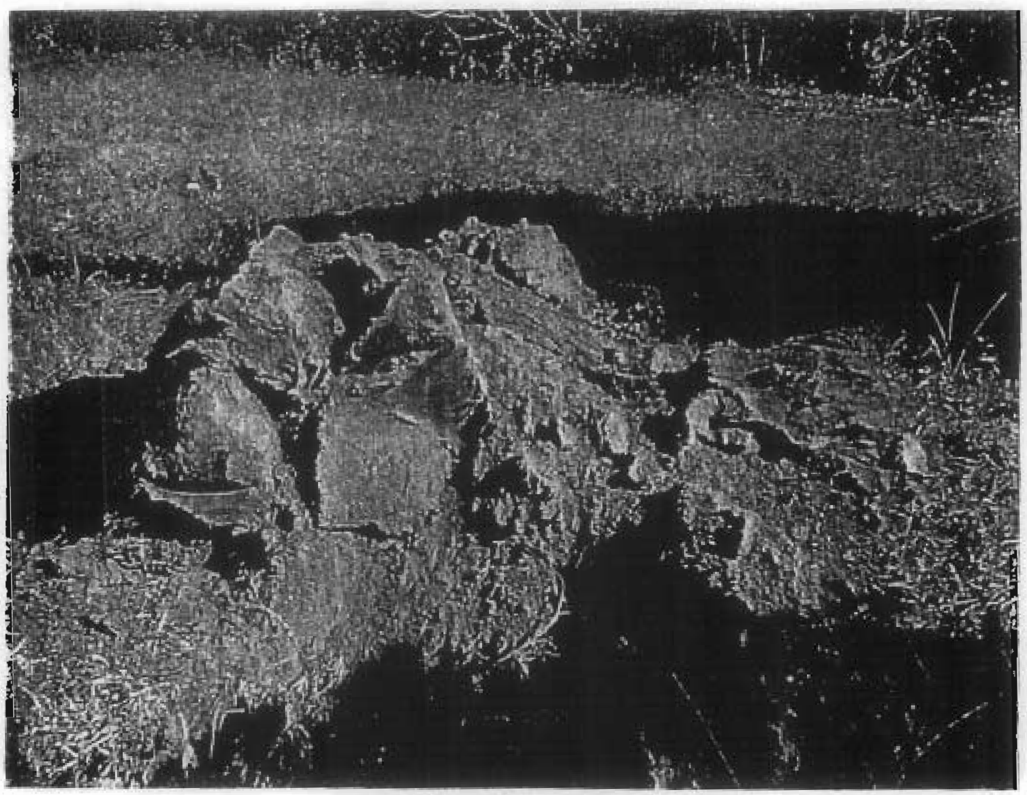


Test Pit #101

Test Pit #103



Test Pit #108



Test Pit #114

Appendix B

Appendix B

Soil-Gas Investigations

As part of the preliminary field work in support of the RCRA Facility Investigation (RFI) effort at Solid Waste Management Unit (SWMU) 9, a geophysical and soil-gas survey was conducted by EnSafe Inc. (EnSafe) in 1992. The following section contains information provided in the *Final Technical Memorandum, Soil-Gas and Geophysics Survey SWMU 9 & SWMU 14* (EnSafe, 1995).

The objectives of the survey were:

- To identify the edges of the landfill, which were poorly defined at the start of the field work,
- To identify clusters of drums buried in the landfill,
- To identify any geophysically detectable leachate plumes or spills originating in the landfill, and
- To identify anomalous soil-gas total volatiles or individual constituents using the EPA Methods 601 and 602 analyses with a gas chromatograph.

This Corrective Measures Study (CMS) Report includes information from the soil-gas survey, since the geophysical survey did not identify conclusive findings on the landfill boundary, buried drum clusters, or the presence of detectable leachate plumes or spills originating in the landfill.

Soil-Gas Survey

The soil-gas survey stations were established on a 100 ft x 100 ft grid pattern, with some additional samples taken to detail plan-view anomalies. Samples were drawn through a ½-inch hole from an average depth of 2 feet below ground surface (bgs). The soil gas was encapsulated in an evacuated glass vial, labeled, and transported to a nearby field laboratory for analysis, usually on the same day. Adequate quality control procedures for sample collection were exercised. The laboratory analysis consisted of two suites:

1. Chlorinated hydrocarbons, by EPA Method 601 (modified), using a gas chromatograph with an electron capture detector, analyzing for:
   1,1-dichloroethene (1,1-DCE), methylene chloride, trans-1,2-dichloroethene (t-1,2-DCE), 1,1-dichloroethane (1,1-DCA), cis-1,2-dichloroethene (c-1,2-DCE), chloroform, 1,1,1-trichloroethane (1,1,1-TCA), carbon-tetrachloride, trichloroethene (TCE), 1,1,2-trichloroethane(1,1,2-TCA) and tetrachlorothene (PCE).

The compounds listed above were chosen because of their common usage in industrial solvents and/or their relationship to commonly used compounds via degradation processes.

2. Volatile hydrocarbons, by EPA Method 602 (modified), using a gas chromatograph with an flame ionization detector (FID), analyzing for:
   Total FID volatiles (referenced to toluene), benzene, toluene, ethylbenzene, meta-, para- and ortho- xylenes. These compounds were chosen because they are typically present in association with fuel products or petroleum-based solvents.

The total FID volatile values were calculated by summing the areas of the chromatograph peaks, excluding methane and injection peaks, and referencing them to the instrument response of toluene. Quality control procedures included field control samples, field duplicate samples and laboratory blanks at an approximate frequency of 10 percent of the regular samples collected.

No specific targeting of methane or other typical landfill gases was included as part of the scope of the soil-gas survey. As such, this survey does not provide information on the presence or absence of such gases at the SWMU 9 landfill area.

Soil-Gas Survey Results

A total of 426 stations were sampled during the soil-gas survey. The results of the survey indicate that at 280 stations, the total FID volatiles were below the 1 micrograms per liter (µg/L) detection limit. This amounts to approximately 89 percent of the areas sampled. Table B-1 shows the data distribution of the total FID volatile concentrations from 426 stations.

TABLE B-1
Data Distribution of Total FID Volatile Detections

Data Range (µg/L)	Number of Samples	Percent of Total
<1.0	280	65.7
1.0 – 1.9	50	11.7
2.0 – 2.9	17	4.0
3.0 – 3.9	6	1.4
4.0 – 4.9	9	2.1
5.0 – 5.9	4	0.9
6.0 – 6.9	2	0.5
7.0 – 7.9	2	0.5

TABLE B-1
Data Distribution of Total FID Volatile Detections

Data Range (μg/L)	Number of Samples	Percent of Total
8.0 – 8.9	3	0.7
9.0 – 9.9	4	0.9
>10.0	49	11.5

Appendix A of the Final Technical Memorandum Preliminary RFI Field Activity report (EnSafe, 1995) includes a copy of the July 1992 soil-gas survey report by Target Environmental Services, Inc., the soil-gas survey contractor for EnSafe. The final technical memorandum presents the spatial distribution of interpreted total FID volatile detections. Areas of significant detections of total volatiles were considered "soil-gas anomalies". Nineteen such anomalies are shown and identified from SG-1 thru SG-19. The soil-gas survey did not conclusively link these anomalies to specific sources of soil-gas within the landfill contents.

Among the 15 organic compounds listed above, the most significant detections were for benzene, toluene, ethylbenzene, xylene, 1,1-DCE, 1,1-DCA and chloroform.

The spatial distribution of benzene detections correlated with the total FID volatile anomalies. However, no significant correlation was established between the total FID volatile anomalies and 1,1-DCE or 1,1-DCA. 1,1-DCE was detected in only four locations above the detection limit of 1 μg/L at 1.2 μg/L (at N3700E2700), 2.5 μg/L (N3500E3400), 7.9 μg/L (N3800E1900) and 70 μg/L (N3800E2000). 1,1-DCA was detected in only one location (N3200E2600) above the detection limit of 1 μg/L at 122 ug/L (N3200E2600).

Figures B-1, B-2, and B-3 (EnSafe, 1995) show the survey locations, the spatial distribution of total FID volatile and analyte detections, respectively. Tables B-2 and B-3 (EnSafe, 1995) list the analytical data from the total FID and ECD results for volatile organic samples.

The soil-gas survey recommended trenching at various locations in order to obtain additional information on subsurface soil conditions at the total volatile soil-gas anomalies detected during the survey. Areas of higher total FID volatile detections were targeted for trenching during a geophysical/intrusive survey conducted by the Environmental Detachment (DET) during 1999 (DET, 1999).

References

EnSafe Inc. *Final Technical Memorandum, Soil-Gas and Geophysics Survey SWMU 9 & SWMU 14*. 1995.

Environmental Detachment Charleston (DET), *Final Geophysical/Intrusive Survey Combined SWMU 9 Closed Landfill, Naval Base Charleston, Charleston, SC*. January 1999.

Target Environmental Services, Inc., Soil Gas Data, Charleston Naval Shipyard. July 1992.

FIGURE 3. Analyte Concentrations via GC/ECD (μg/l)

CHARLESTON NAVAL SHIPYARD
CHARLESTON, SOUTH CAROLINA

ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

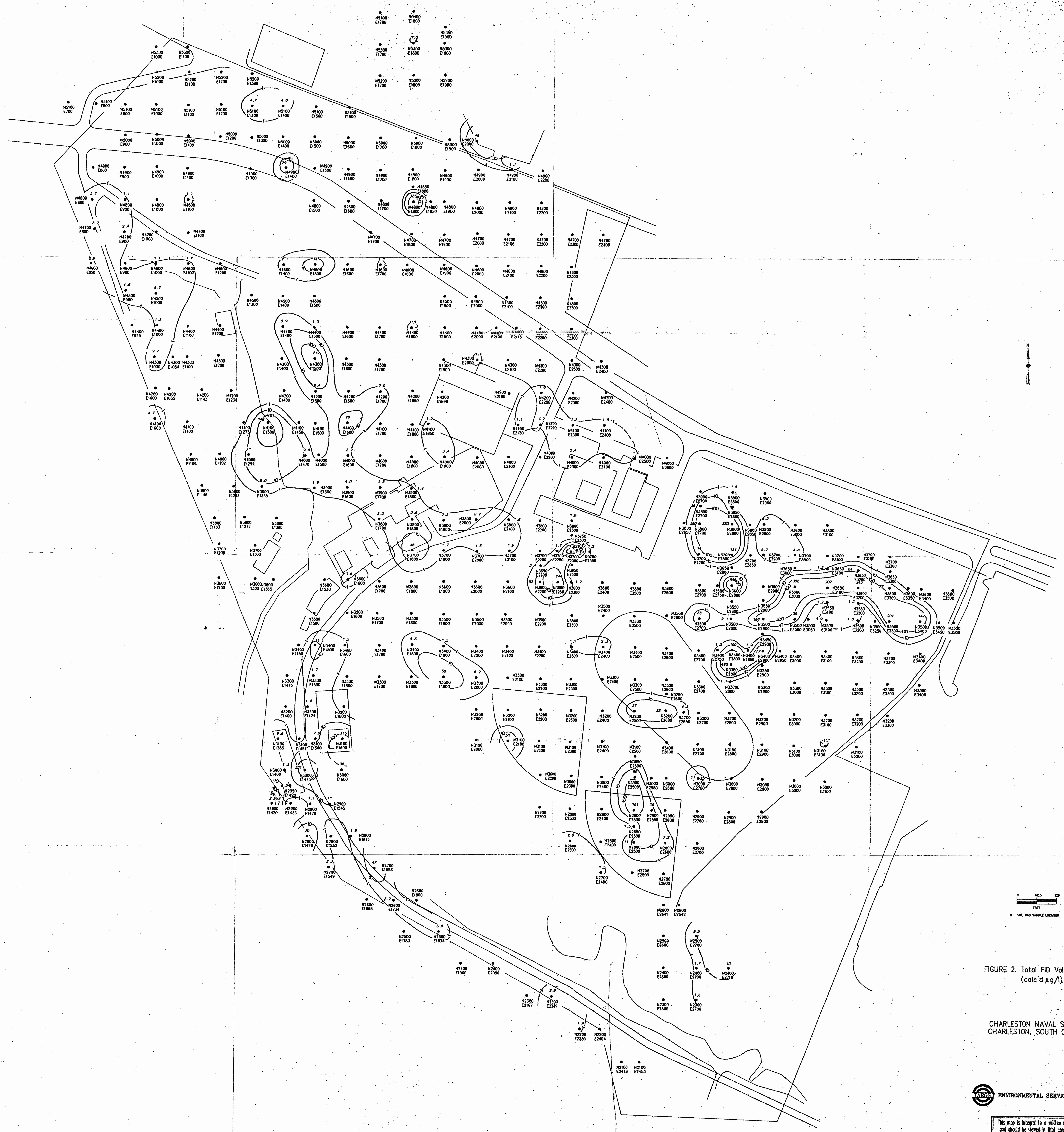


FIGURE 2. Total FID Volatiles (calc'd µg/l)

CHARLESTON NAVAL SHIPYARD
CHARLESTON, SOUTH CAROLINA

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

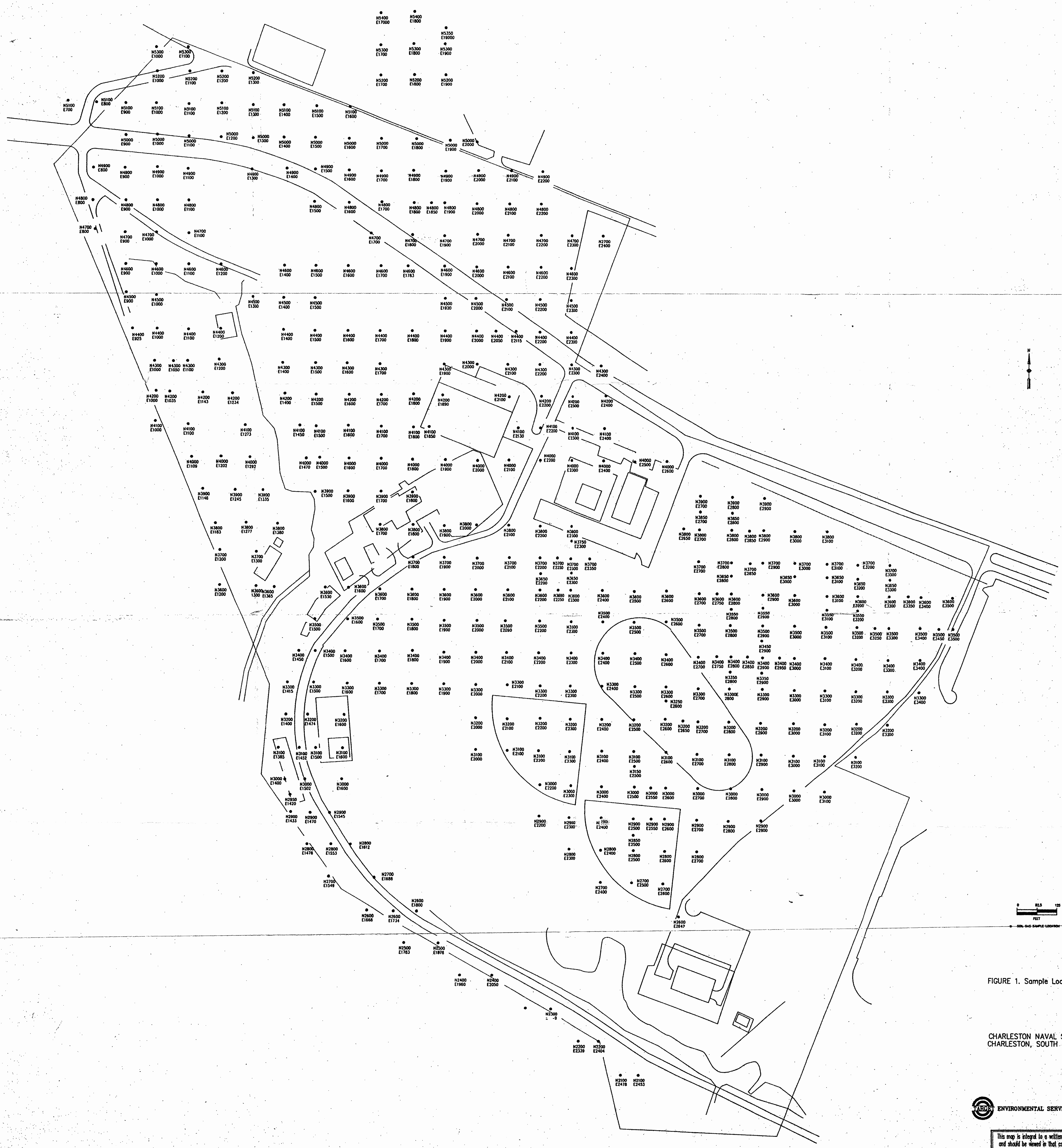


FIGURE 1. Sample Locations

CHARLESTON NAVAL SHIPYARD
CHARLESTON, SOUTH CAROLINA

ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

Appendix C

Table C-1
Preliminary Cost Estimate
Presumptive Remedy Alternative: In-Place Waste Containment
Combined SWMU 9, Charleston Naval Complex, Charleston, South Carolina

Item Description	Quantity	Unit	Unit Cost	Extended Cost	Comments
Preconstruction:					
Landfill Gas Investigation	3.0	Crew-Day	$1,300.00	$3,900	$65/hr, 8x2 hrs, $250 supplies
Establish Survey Controls	1.0	Lump Sum	$1,000.00	$1,000	Two permanent monuments @ $500/each
Construction:					
Mobilization	1.0	Lump sum	$7,600.00	$7,600	4% of Construction Subtotal
Site Preparation					
Survey	3.0	Crew-Day	$1,200.00	$3,600	Hot spot locations, grading areas staking, 3 person crew
Prepare staging/laydown areas	1.0	Lump sum	$1,000.00	$1,000	
Site Clearing	5.00	Acre	$4,175.00	$20,875	Means
Erosion Control					
Silt fence	2,000.0	LF	$1.10	$2,200	
Hay bales	3.0	ton	$365.00	$1,095	
Landfill Cover repair					
Initial grade and compact	2.0	acre	$5,600.00	$11,200	
Place and compact fill	2,420.0	CY	$17.00	$41,140	In-place, 1' thick, 1.5 acre, clean, imported fill
Final Grading	2.0	acre	$2,300.00	$4,600	
Establish Vegetation	2.0	Acre	$1,800.00	$3,600	
Drainage Improvements					
Grade/fill to establish drainage ditches	1.0	Lump Sum	$10,000.00	$10,000	Approx. 10' wide grading, 1,000 LF
Erosion mat	556	SY	$8.00	$4,444	Approx. 10' wide, 500 LF
Sodding	556	SY	$3.00	$1,667	Approx. 10' wide, 500 LF
Geotextile	5,000	SF	$0.20	$1,000	Approx. 10' wide, 500 LF
Riprap	333	Ton	$50.00	$16,667	Avg 10" deep, 10'x500', 160 lbs/CY
Landfill Gas					
Drill vents	180	LF	$20.00	$3,600	12" dia, 6' deep, 30
Install vents	180	LF	$65.00	$11,700	
Surface completion	30	Each	$280.00	$8,400	pad-$50, 4' stickup-$80, wind turbine-$150
As-Built survey	3.0	Crew-Day	$1,200.00	$3,600	3-person crew
Site Restoration	5.0	acre	$1,800.00	$9,000	
Demobilization	1.0	Lump Sum	$5,750.00	$5,750	Approx 3% of Construction Subtotal
Miscellaneous					
Insurance and Bonds	1.0	Lump sum	$4,750.00	$4,750	Approx 2.5% of Construction Subtotal

Table C-1
Preliminary Cost Estimate
Presumptive Remedy Alternative: In-Place Waste Containment
Combined SWMU 9, Charleston Naval Complex, Charleston, South Carolina

Item Description	Quantity	Unit	Unit Cost	Extended Cost	Comments
CONSTRUCTION SUBTOTAL:				**$182,388**	
Procurement/Contract Administration:			10%	$18,238.78	
Construction QA/QC			10%	$18,238.78	
Documentation and reporting			10%	$18,238.78	
Construction Management			15%	$27,358.17	
Engineering Design Cost:			15%	$27,358.17	
TOTAL CONSTRUCTION COST				***$291,820***	
O&M Costs:					
Year 1:					
Quarterly Sampling	4	Event	$20,000	$80,000	21 wells, VOCs, metals
Data Analysis/report	4	Event	$3,000	$12,000	
Landfill Inspection/Repair	1	Lump Sum	$9,119	$9,119	Semiannual, 5% of Construction Subtotal Cost
			Year 1 O&M Costs:	**$101,119**	
Year 2 to Year 30:					
Annual Sampling	1	Event	$20,000	$20,000	
Data Analysis/report	1	Event	$3,000	$3,000	
Landfill Inspection/Repair	1	Lump Sum	$9,442	$9,442	
			Years 2-30 Annual O&M Costs:	**$32,442**	

Total capital Cost (Construction+Year 1 O&M): $392,940
Present Worth for O&M for Years 2-30: $696,000

Total Remedy Cost in Present Worth: $1,088,940

Remedy Cost Range (-30% and +50%): 32,260 - $1,633,410

Appendix D

Site:	SWMU 121
Media:	Surface Soil
Units:	ppm
Chemical:	Aroclor-1254
CASRN:	

STATISTICS	
N	16
Detects	6
FOD	38%
Mean of Detect	0.927
Min of Detect	0.1400
Max of Detect	4.30
Best Estimate of Mean (arithmetic)	0.4
Best Estimate of Mean (geometric)	0.1
Nondetects at 1/2 DL	YES

95% UPPER CONFIDENCE LIMITS FOR MEAN	
UCL95 Normal	0.8
t-statistic	1.75
UCL95 Lognormal	1.0
H-statistic	3.36
UCL95 Nonparametric	0.02
UCL95 Bootstrap	1

95% UPPER TOLERANCE INTERVAL	
UTL95 Normal	2.270395373
coverage	95%
UTL95 Lognormal	1.181249137
coverage	95%
UTL95 Nonparametric	4.30
coverage	94%

DISTRIBUTION TESTING	
Population is best described as:	NONPARAMETRIC
W_{normal}	0.352
W_{log}	0.714
$W_{\alpha = 0.05}$	0.887

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values. The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If there is >90% nondetection, it is generally impossible to caclulate a UTL or UCL with any level of confidence.

Site: SWMU 121
Media: Surface Soil
Units: ppm

Chemical	CASRN	Samples	Detects	NonDetects	FOO	Min Detect	Max Detect	Avg Detect	Mean	Min nondetect	Max nondetect	W-Test	t-Statistic	UCL95 norm	H-statistic	UCL96 log	UCL95 nonparm	UCL95 bootstrap	UTL norm	UTL log	UTL nonparm
Arsenic	SWMU 19	17	14	3	82%	3	22.1	9.907143	8.535294	1	4.1	LOGNORMAL	1.746	11.29835	2.352333	15.47329	3.8	11.23538	20.25797	30.46854	22 1
BEQ		17	12	5	71%	316.3	2524.9	846.5473	707.3353	207.99	924.4	LOGNORMAL	1.746	986.6549	2.229333	1051.342	248.4325	968.87	1892.388	2005.834	2524.9
BEQ		20	10	10	50%	313.686	3075.15	743.7453	495.8	231.1	259.9875	NONPARAMETRIC	1.729	744.2943	2.165	613.4652	248.4325	727.8153	1634.544	1128.303	3075.15
Arsenic		16	11	5	69%	3.5	18.7	8.627273	6.95625	0.8	6.75	NORMAL	1.753	8.907896	2.329667	12.45425	3.5	8.757326	15.00309	23.89895	18.7
Aroclor-1254		16	6	10	38%	0 14	4.3	0.926667	0.36	0.02	0.02	NONPARAMETRIC	1.753	0.823339	3.361167	0.972966	0.02	0.743054	2.270395	1 181249	4.3

Site:	SWMU 121
Media:	Surface Soil
Units:	ppb
Chemical:	BEQ
CASRN:	

STATISTICS	
N	17
Detects	12
FOD	71%
Mean of Detect	846.547
Min of Detect	316.3000
Max of Detect	2524.90
Best Estimate of Mean (arithmetic)	707.3
Best Estimate of Mean (geometric)	525.6
Nondetects at 1/2 DL	YES

95% UPPER CONFIDENCE LIMITS FOR MEAN	
UCL95 Normal	986.7
t-statistic	1.75
UCL95 Lognormal	1051.3
H-statistic	2.23
UCL95 Nonparametric	248.4325
UCL95 Bootstrap	969

95% UPPER TOLERANCE INTERVAL	
UTL95 Normal	1892.387942
coverage	95%
UTL95 Lognormal	2005.833961
coverage	95%
UTL95 Nonparametric	2524.90
coverage	94%

DISTRIBUTION TESTING	
Population is best described as:	LOGNORMAL
W_{normal}	0.715
W_{log}	0.913
$W_{\alpha=0.05}$	0.892

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values. The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If there is >90% nondetection, it is generally impossible to caclulate a UTL or UCL with any level of confidence.

Site:	AOC 650
Media:	Surface Soil
Units:	ppb
Chemical:	BEQ
CASRN:	

STATISTICS

N	20
Detects	10
FOD	50%
Mean of Detect	743.745
Min of Detect	313.6860
Max of Detect	3075.15
Best Estimate of Mean (arithmetic)	495.8
Best Estimate of Mean (geometric)	365.0
Nondetects at 1/2 DL	YES

95% UPPER CONFIDENCE LIMITS FOR MEAN

UCL95 Normal	744.3
t-statistic	1.73
UCL95 Lognormal	613.5
H-statistic	2.17
UCL95 Nonparametric	248.4325
UCL95 Bootstrap	739

95% UPPER TOLERANCE INTERVAL

UTL95 Normal	1634.543938
coverage	95%
UTL95 Lognormal	1128.303273
coverage	95%
UTL95 Nonparametric	3075.15
coverage	95%

DISTRIBUTION TESTING

Population is best described as:	NONPARAMETRIC
W_{normal}	0.432
W_{log}	0.689
$W_{\alpha=0.05}$	0.905

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values. The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If there is >90% nondetection, it is generally impossible to caclulate a UTL or UCL with any level of confidence.

Site:	SWMU 19
Media:	Surface Soil
Units:	ppm
Chemical:	Arsenic

STATISTICS

N	17
Detects	14
FOD	82%
Mean of Detect	9.907
Min of Detect	3.0000
Max of Detect	22.10
Best Estimate of Mean (arithmetic)	8.5
Best Estimate of Mean (geometric)	6.2
Nondetects at 1/2 DL	YES

95% UPPER CONFIDENCE LIMITS FOR MEAN

UCL95 Normal	11.3
t-statistic	1.75
UCL95 Lognormal	15.5
H-statistic	2.35
UCL95 Nonparametric	3.8
UCL95 Bootstrap	11

95% UPPER TOLERANCE INTERVAL

UTL95 Normal	20.25796599
coverage	95%
UTL95 Lognormal	30.46853734
coverage	95%
UTL95 Nonparametric	22.10
coverage	94%

DISTRIBUTION TESTING

Population is best described as:	LOGNORMAL
W_{normal}	0.886
W_{log}	0.954
$W_{\alpha = 0.05}$	0.892

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values. The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If there is >90% nondetection, it is generally impossible to caclulate a UTL or UCL with any level of confidence.

Site:	SWMU 121
Media:	Surface Soil
Units:	ppm
Chemical:	Arsenic
CASRN:	

STATISTICS

N	16
Detects	11
FOD	69%
Mean of Detect	8.627
Min of Detect	3.5000
Max of Detect	18.70
Best Estimate of Mean (arithmetic)	7.0
Best Estimate of Mean (geometric)	5.4
Nondetects at 1/2 DL	YES

95% UPPER CONFIDENCE LIMITS FOR MEAN

UCL95 Normal	8.9
t-statistic	1.75
UCL95 Lognormal	12.5
H-statistic	2.33
UCL95 Nonparametric	3.5
UCL95 Bootstrap	9

95% UPPER TOLERANCE INTERVAL

UTL95 Normal	15.00309315
coverage	95%
UTL95 Lognormal	23.89895056
coverage	95%
UTL95 Nonparametric	18.70
coverage	94%

DISTRIBUTION TESTING

Population is best described as:	NORMAL
W_{normal}	0.932
W_{log}	0.912
$W_{\alpha=0.05}$	0.887

Notes:

1. If population does not fit normal or lognormal distribution, check Q-Q plots and W-test values. The population may be close enough to one of those distributions to subjectively select a normal or lognormal distribution.
2. For site data, if the selected UCL95 exceeds the Max Detect, the Max Detect should be chosen as the EPC.
3. Lognormal UCL or UTL values caculated for less than 30 samples may be widely inflated.
4. If there is >90% nondetection, it is generally impossible to caclulate a UTL or UCL with any level of confidence.

Chemical	SOIL INTERVAL	LOCATION	Samples	Detects	NonDetects	FOD	Min Detect	Max Detect	Avg Detect	Mean	Min nondetect	Max nondetect	W-Test	UCL95 norm	UCL95 log	UCL95 bootstrap
AS	SURFACE SOIL	SWMU 9	17	14	3	82%	3.0	22	9.9	8.5	1.0	4.1	LOGNORMAL	11	[illegible]	11
BEQ	SURFACE SOIL	SWMU 121	17	12	5	71%	316	2,525	847	707	208	924	LOGNORMAL	987	[illegible]	976
BEQ	SURFACE SOIL	AOC 649/650	20	10	10	50%	314	3,075	744	496	231	260	NONPARAMETRIC	744	613	[illegible]
AS	SURFACE SOIL	SWMU 121	16	11	5	69%	3.5	19	8.6	7.0	0.80	6.8	NORMAL	[illegible]	12	8.9
AROCLOR-1254	SURFACE SOIL	SWMU 121	16	6	10	38%	0.14	4.3	0.93	0.36	0.020	0.020	NONPARAMETRIC	0.82	0.97	0.80

Appendix E

CH2MHILL TRANSMITTAL

To: Mr. David Scaturo
South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

From: Dean Williamson/CH2M-Jones

Date: September 26, 2003

Re: CH2M-Jones' Revised Responses to Comments by SCDHEC regarding the *CMS Report, Combined SWMU 9, Zone H, Revision 0* – Originally Submitted on January 31, 2003

We Are Sending You:

X	**Attached**	Under separate cover via	
	Shop Drawings	Documents	Tracings
	Prints	Specifications	Catalogs
	Copy of letter	Other:	

Quantity	Description
4	Revised Responses to Comments by SCDHEC regarding the *CMS Report, Combined SWMU 9, Zone H, Revision 0* – Originally Submitted on January 31, 2003

If material received is not as listed, please notify us at once.

Copy To:

Dann Spariosu/USEPA, w/att
Rob Harrell/Navy, w/att
Gary Foster/CH2M HILL, w/att

Revised Responses to Comments by SCDHEC
Corrective Measures Study Report, Revision 0
SWMU 9, Zone H
Charleston Naval Complex (CNC)
Dated January 2003

Comments Prepared by Jerry Stamps, dated April 23, 2003

1. General

As stated in the text, Land Use Controls (LUCs) will be applied to the landfill to ensure industrial reuse. Therefore, screening the surface soil data against the EPA Region III Industrial RBC is appropriate for all SWMUs and AOCs included in the combined SWMU 9 footprint. No response to this comment is necessary.

2. General

Typically 2 feet of cover is necessary to prevent exposure of waste material contained within the landfill. The Navy should justify that 1 foot of soil cover will be sufficient to prevent such exposure.

CH2M-Jones Response:

The existing landfill cover thickness is 2 feet or greater in about half or more of the SWMU 9 landfill area, as shown in Figure 2-10. There are two small areas where the existing landfill cover thickness is about 1 foot, also as shown in Figure 2-10.

We agree with the reviewer that 2 feet of soil cover is generally accepted as a typical cover value for landfills to ensure that waste is adequately covered. This value is a conservative thickness that is applied to a wide variety of landfill terrains, including those with steep slopes or other areas where significant erosional forces are present. However, the topography at SWMU 9 is flat, with very low grades and significant vegetative cover. The surface erosional forces at SWMU 9 are low and the potential for significant erosion is minimal. Since the closure of the landfill during the early 1970s, no noticeable erosion of the landfill cover is evident, confirming that the erosional forces are minimal and indicating that the existing cover thickness is providing adequate protection against erosion and direct exposure to buried landfill wastes. The 30-year period over which the existing cover has demonstrated both stability and the ability to keep the waste covered is of a sufficiently long duration for the cover to demonstrate its long-term stability.

We have proposed in the corrective measures study (CMS) to provide additional fill to areas that appear to have minimal soil cover. As a result of applying additional cover, all of the landfill will have at least 1 foot of cover, a significant portion of the landfill will have at least 1.5 feet of cover, and approximately half or more of the landfill will have 2 feet or more of soil cover.

Additionally, as part of the long-term operation and maintenance (O&M), the CH2M-Jones/Navy team will provide periodic inspections of the landfill cover at a frequency adequate to determine if cover erosion is beginning to occur. In the event that surface erosion appears to be leading to the potential for waste to be exposed, appropriate additional actions will be performed to stabilize or replace the cover as necessary to preclude waste exposure and *ensure long-term cover stability. Thus, the soil cover remedial approach, as proposed in the CMS, will provide for a landfill cover that is protective of human health and the environment.*

3. General

a. The Navy must demonstrate that the existing cover will be sufficient to reduce infiltration. In order to do so, the Navy may evaluate the permeability of the current cover relative to the permeability of the native soil outside the footprint of the landfill. Please see the correspondence from Scaturo to Daniel dated September 27, 2001 pertaining to the SWMU 9 CMS Work Plan identifying the need to evaluate the characteristics of the current cover.

CH2M-Jones Response:

It is important to note that infiltration of water through a landfill cover is not solely a function of the permeability of the soil cover. Other parameters, such as the amount and type of vegetative cover, landfill grades and slopes, meteorological setting, and climate, also significantly affect the amount of stormwater infiltrating through a cover. Because of these factors, vegetative (or phyto-) covers, many of which involve the cultivation of trees, are increasingly being used over traditional clay/soil covers as final landfill covers.

In order to address SCDHEC questions about infiltration through the landfill cover, CH2M-Jones proposes to conduct an evaluation of potential net infiltration through the landfill cover and a comparison with the net infiltration in areas adjacent to the landfill. A model, such as Hydrologic Evaluation of Landfill Performance (HELP) will be used for this evaluation. The HELP model accepts weather, soil, and design data and uses solution techniques that account for the effects of surface storage, runoff, infiltration, evapo-transpiration, vegetative growth, soil moisture storage, lateral subsurface drainage, unsaturated vertical drainage, and leakage through soil, along with other cover components that may be present (such as geomembrane or composite liners).

It is also important to note that groundwater monitoring to date indicates that the existing cover provides adequate impermeability. As noted in the response to Comment 2 from Jerry Stamps and in response to comments from Jo Cherie Overcash, after 30 years of closure, no groundwater plumes that would cause unacceptable risks to human or ecological receptors are migrating from the landfill. These data indicate that excessive permeability of the existing cover is not a concern.

b. Furthermore, as a means of "hot spot" treatment, the Department recommends placing a low permeability cover over the specific areas of known groundwater contamination. For example, the area near SWMU 20 with the chlorinated solvent contamination and the area near AOC 706 with the elevated barium concentrations in the groundwater are good candidates for this type of treatment. These localized areas of low permeability cover will minimize infiltration and reduce the potential for contamination migration.

CH2M-Jones Response:

As noted in the response to the comments provided by Jo Cherie Overcash, there does not appear to be a need for any active corrective measures to address plume migration at any *areas at Combined SWMU 9, including SWMU 20 (for chlorobenzene in groundwater) or AOC 706 (for barium in groundwater). The data do not indicate that a groundwater plume that would cause unacceptable impacts to human or ecological receptors is exiting or approaching the landfill boundary.*

In the vicinity of SWMU 20, detections of chlorobenzene in well H009GW014 indicate its presence in groundwater in this area. However, the single detection of chlorobenzene at 140 µg/L does not support a conclusion that a groundwater plume at concentrations exceeding the MCL or that may cause an unacceptable risk to ecological receptors is discharging into Shipyard Creek. This detection was preceded by six detections below the MCL of 100 µg/L and EPA Region IV saltwater chronic toxicity value (SWCTV) of 105 µg/L, and followed by two detections below the MCL and SWCTV, with the most recent results (January 2003) below laboratory detection limits. This well is being included in the long-term monitoring network for SWMU 9. At the present time, the chlorobenzene detections in this well do not appear to be of such significance that corrective measures are warranted.

The detections of barium in G706GW001, particularly during the most recent sampling events, do not consistently exceed their respective MCLs. At G706GW001, four additional samples have been collected since the barium detection of 2,279 µg/L (from July 1999) shown in Table 2-6 of the CMS Report, Revision 0. These four succeeding barium detections were 2,300 µg/L, 810 µg/L, 1,500 µg/L and 1,080 µg/L, in samples collected during June 2002, July 2002, September 2002, and January 2003, respectively. Seven out of nine historical detections of barium have been below the MCL of 2,000 µg/L in this well, indicating that although barium is present in the groundwater in this well, it does not pose a threat to groundwater quality. However, barium has been retained as a groundwater COC and will be periodically monitored. Additionally, the landfill boundary is being proposed to include AOC 706, and this well will now be considered to be within the landfill. An evaluation will be made to consider alternate existing or new wells north of AOC 706 to act as perimeter monitoring wells in this area.

The overall approach for selecting an appropriate corrective measures remedy for Combined SWMU 9, as described in the CMS Report, Revision 0, follows the presumptive remedy approach and uses a monitoring approach to ensure that unacceptable migration from the landfill does not occur. As noted above, there is no indication at this time that the hot spot treatment is necessary to prevent unacceptable migration from the landfill. Should conditions arise where unacceptable migration of contamination is found to be occurring, the potential benefits of a partial low permeability cover could be considered at that time along with other potential actions, and if found to be part of an applicable remedy, it could be implemented at that time.

4. Section 2.1

This section should state that AOC 654 was excluded from the CMS process because it was granted a No Further Action (NFA) from the Department on August 28, 1997.

CH2M-Jones Response:

Comment noted. The text will be revised to include this information in Revision 1 of the CMS Report for Combined SWMU 9.

5. Section 2.2.7.3.1, Table 2-2

The BEQ concentration at sample H020SB011 is reported as 1,502.15U ppb. This reported value, though apparently non-detect according to Table 2-2, exceeds the basewide reference concentration for BEQs. The Navy must explain why such a high value is reported with a non-detect qualifier.

CH2M-Jones Response:

The reported BEQ value of 1,502 ppb is not a true exceedance of the sitewide reference concentration. The seven individual PAH compounds that make up the BEQs were all below laboratory detection limits in this sample. None of the seven BEQs were detected in this sample. Therefore, a "U" qualifier was associated with the BEQ concentration. The higher concentration reported is due to a higher detection limit (1,300 μg/kg) associated with the sample data group (SDG) that this sample belonged to. This typically occurs when a sample is diluted due to the elevated concentration of one or more chemicals in the SDG. The concentrations of the individual PAHs were considered at half this detection limit (or 650 μg/kg) during the calculation of the BEQ concentration, which resulted in the final calculated BEQ value being higher than the CNC BEQ sitewide reference concentration of 1,304 μg/kg for surface soils.

6. Section 2.2.7.4.1, Table 2-3, SWMU 121

a. The BEQ concentration at sample H121SB005 is reported as 1,848.80U ppb. This reported value, though apparently non-detect according to Table 2-3, exceeds the basewide reference concentration for BEQs. The Navy must explain why such a high value is reported with a non-detect qualifier.

CH2M-Jones Response:

Similar to the results for sample H020SB011, none of the seven PAH compounds included in the BEQ calculation showed detections above laboratory detection limits. Please see the explanation provided in the response to Comment 5 from Jerry Stamps.

b. H121SB011, H121SB013, and possibly H121SB005 exceed both the industrial RBC and basewide reference concentration. The extent of this BEQ contamination at these locations has not been fully delineated, particularly SB013 and SB005, as they do not have any nearby soil sample locations. Consequently, the Department recommends ensuring additional cover is added to this area to eliminate the exposure pathway to the BEQ contamination.

CH2M-Jones Response:

As explained in the responses to Comments 5 and 6a from Jerry Stamps, the BEQ concentrations at H121SB011 and H121SB005 are below laboratory detection limits. Since they were non-detect, these concentrations are not considered an exceedance of the CNC sitewide reference concentration for surface soils. BEQ concentrations at the other location (H121SB013) represent 1 out of 17 sample locations in this area showing an exceedance of the CNC sitewide reference concentration for surface soils. At 15 other locations, the BEQ concentrations were substantially lower than the CNC sitewide reference concentrations or below laboratory detection limits, as shown in Table 2-3 of the CMS Report, Revision 0.

Sample location H121SB011 is bounded by sample locations showing BEQ concentrations below the CNC sitewide reference concentrations. A roadway exists approximately 50 feet to the west of sample location H121SB013 and previous roadway activity would likely increase the potential of elevated BEQ concentrations. Two other sample locations, H121SB005 and H121SB006, bound this sample on the northeast and southeast sides approximately 60 feet away, with BEQ detections below the CNC sitewide reference concentration. The infrequent BEQ exceedances do not indicate a BEQ source area that could cause an exposure concern. Additionally, the average existing landfill cover thickness in this area is about 1.5 feet, which is sufficient to prevent direct exposure at these two locations.

7. Section 2.2.7.5, Table 2-4

Table 2-4 incorrectly identifies the EPA Region III Industrial RBC as 82 mg/kg rather than 3.8 mg/kg as identified in the October 2002 version of the RBC table. Please revise accordingly.

CH2M-Jones Response:

Comment noted. Table 2-4 will be revised accordingly.

8. Section 3.4.4 and Section 5.4.2.3

Given the chlorinated solvents present in the groundwater in the vicinity of SWMU 20 and adjacent to Shipyard Creek, the Department recommends including surface water and sediment sampling into the Long Term Monitoring program.

CH2M-Jones Response:

We agree that periodic surface water sampling in Shipyard Creek should be considered to verify the absence of contamination or potential migration. Provisions for periodic surface water sampling can be included in the O&M plan for SWMU 9. However, because Shipyard Creek mixes with water from the Cooper River and because discharges to Shipyard Creek from other areas along the creek could cause detection of contamination, careful interpretation of the data will be needed.

Similarly, with regard to sediment sampling, the work done by the Navy/EnSafe team as part of the Zone J RFI effort indicates that assessing the origin of any contamination detected in sediment samples may be difficult, because of the significant influx of sediment from the Cooper River, which may arise from a variety of sources. Cooper River sediment, which may originate in the upriver portions of the Cooper River or in the Wando and Ashley Rivers (because of the tidal excursion cycle), tends to settle out in Shipyard Creek, since Shipyard Creek has low water velocities relative to the Cooper River. Data presented by EnSafe at a recent BCT meeting indicate that sediment loads of approximately 580,000 pounds per year enter Shipyard Creek from a variety of sources, such as stormwater runoff.

However, CH2M-Jones agrees that periodic sediment sampling for specific contaminants that may be suspected of migrating from SWMU 9 into Shipyard Creek would be worth conducting where conditions indicate that such sampling may yield important information regarding potential impacts from the landfill. An example of such a condition would be where a groundwater plume is determined to be potentially migrating into the creek. As such *conditions arise, CH2M-Jones will work with the Department to develop an appropriate sediment sampling rationale and include such sediment sampling in the monitoring program.*

9. Section 5.4.1

This section should discuss that the LUCs will be incorporated into the RCRA permit.

CH2M-Jones Response:

Comment noted. The text in Section 5.4.1 will be revised accordingly.

10. Appendix A

a. It is stated that the IM conducted at SWMU 8 removed the landfill waste material and, therefore, SWMU 8 should no longer be considered within the footprint of SWMU 9. Based upon the apparent intermittent nature of the discovery of waste material, it seems unlikely that all waste material associated with the landfill has been removed from the footprint of SWMU 8. The Navy should provide additional evidence supporting the fact that SWMU 8 should not be considered a part of the combined SWMU 9 footprint.

CH2M-Jones Response:

The portion of SWMU 8 where most of the contamination occurred was within the three trenches used for disposal of waste oil and subsequently covered with soil. These trenches were later uncovered and the waste oil removed, as described in Interim Measure Completion Report for this effort. This type of disposal trench is not typically considered to be a landfill, and with the removal of the waste oil and subsequent backfilling with gravel and fill, this area should not be considered part of SWMU 9. Test trenches installed by the DET within SWMU 8 between the former waste oil disposal trenches and Dyess Avenue were reported by the DET to contain household trash, wood, metal strapping, plastic, broken concrete, and rebar. Based on these results, this area may be considered to be part of SWMU 9.

The southern portion of SWMU 8 where landfill debris was found in the test pits dug during the DET's IM is being included in the landfill footprint as shown in Figure 2-1 of the CMS Report, Revision 0. The text in Appendix A will be revised to indicate that the southern portion of SWMU 8 is being included in the landfill footprint. There is no evidence of landfill material being present in the remaining areas of SWMU 8, which are undergoing LUCs, as indicated in the CMS Report for SWMU 8, Revision 0 *(CH2M-Jones, 2003).*

b. AOC 706 appears to be excluded form the footprint of the landfill; however, the Finding of Suitability for Early Transfer (FOSET) identifies this area as requiring land use controls (LUCs). Given the elevated barium that has been detected in the groundwater in this area, the Department recommends extending the boundary of SWMU 9 to include AOC 706 and, therefore, be consistent with the extent of the LUCs identified in the FOSET.

CH2M-Jones Response:

We agree that AOC 706 can be included as part of the SWMU 9 landfill footprint. Many of the test trenches installed by the DET at the edge of AOC 706 as part of their landfill boundary assessment were found to contain solid waste material, such as glass, wood sheet *metal, strapping, copper cable, broken drain tile, metal conduit. It is reasonable to conclude that the AOC 706 subsurface environment may also contain these types of waste materials.*

11. Appendix B

This section should discuss the soil gas investigation that is currently ongoing.

CH2M-Jones Response:

Additional information from the recent soil gas investigation will be included in Revision 1 of the CMS Report for Combined SWMU 9.

Comments Prepared by Jo Cherie Overcash, dated April 30, 2003

General Comments

Groundwater Dataset

1. The Navy states that the list of groundwater constituents of concern is based on "the most current analytical data available for each well,..." According to the facility's GIS database, the majority of the monitoring wells at Combined SWMU 9 have been sampled less than eight times since 1994. Due to the limited dataset, the Navy must consider all available data and revise the list of COCs as appropriate.

Moreover, the associated Figures 2-12 through 2-14 do not depict a complete picture of groundwater quality at Combined SWMU 9 due to being limited to the "most recent" data. The groundwater condition is dynamic in that a release to soil or directly to groundwater changes groundwater quality over time. These Figures cannot sufficiently represent a contaminant plume migrating though time. For instance, chlorobenzene was detected in monitoring well H009GW014 for the first time during the June 2002 sampling event. Chlorobenzene was again detected in this same well during the September 2002 sampling event. Of concern is that even though the concentration of chlorobenzene in this well fluctuated (140 μg/L and 24 μg/L) from above to below the MCL of 100 μg/L, the detection of this contaminant in this well at this time indicates a migrating plume. Of specific concern also is that H009GW014 is located approximately 106 feet from the eastern bank of Shipyard Creek.

CH2M-Jones Response:

For most parameter groups, such as VOCs and SVOCs, data from previous groundwater sampling efforts, not just the latest sampling results, were evaluated in developing the list of COPCs and COCs. As indicated on page 2-13, lines 12 and 13, results from the earlier RFI groundwater sampling events were evaluated as part of the COC development. A discussion of the COPCs identified during the course of various sampling events is provided in Section 2.2.7.8. Table 2-6 summarizes data for COPCs that were not considered COCs and Section 2.2.7.8. provides the rationale as to why a chemical was or was not retained as a COC. The text in this section will be revised to clarify the discussion of COC selection.

The COC list presented in the CMS Report, Revision 0, is similar to the COC list presented in the Zone H RFI Report, Revision 0 *(EnSafe, 1996). As noted in the following comments, we agree that additional chemicals may be considered as COCs for the purposes of long-term* *groundwater monitoring (such as 2-methylphenol and barium, as discussed in other responses to comments herein).*

For pesticides, the most recent data were used as the basis for selecting groundwater COCs in the CMS Report, Revision 0, since these data are considered most representative of current conditions and because of the limited number of previous detections and low migration potential of these contaminants. The attached Table 1 lists pesticides detected during the previous groundwater sampling activities at SWMU 9. For Revision 1 of the CMS Report for Combined SWMU 9, an evaluation of pesticides as groundwater COCs using all previous data will be provided and, if warranted, pesticides will be included as COCs. Given the unknown nature of materials that were disposed of in the landfill, CH2M-Jones is not opposed to periodic monitoring for pesticides in groundwater as part of the long-term monitoring for this site.

Chlorobenzene is identified as a groundwater COC in the CMS Report, Revision 0. While the detections of chlorobenzene in well H009GW014 indicate its presence in groundwater in this area, the single detection of 140 μg/L does not support a conclusion that concentrations exceeding the MCL or that may cause an unacceptable risk to ecological receptors are being introduced into Shipyard Creek. This detection was preceded by six detections below the MCL of 100 μg/L, and followed by two detections below the MCL, with the most recent results (January 2003) being below laboratory detection limits. This well is being included in the long-term monitoring network for SWMU 9. At the present time, the chlorobenzene detections in this well do not appear to be of such significance that corrective measures are warranted.

It should also be noted that for a chemical potentially discharging via contaminated groundwater from the landfill into Shipyard Creek, the applicable concentration of concern should be derived from saltwater chronic toxicity value (SWCTV), taking surface water dilution effects into account rather than the drinking water MCL. The reason for this is that Shipyard Creek is not used for drinking water but does provide saltwater habitat. Depending on monitoring results in the future, it may be appropriate to develop applicable Media Cleanup Standards (MCS) or action levels based on the SWCTVs for specific chemicals.

Due to the nature of the buried wastes, mapping a plume inside the landfill boundary does not provide useful information for altering the presumptive remedy for this landfill. Should a contaminant plume be approaching or exiting the boundary of the landfill at concentrations that present an unacceptable risk to human or ecological receptors, the need for additional corrective actions would be considered. There is no evidence from historical analytical data derived from sampling wells near the landfill boundary that a contaminant plume of this nature is exiting the SWMU 9 boundary.

2. Throughout Section 2.2.7.8 Combined SWMU 9 Groundwater, the Navy differentiates between monitoring wells that are located within the boundary of the unit and those wells beyond the boundary. For example, in Section 2.2.7.8.4.2 Arsenic, the Navy states that deep monitoring well H009GW24D has been sampled once for arsenic and is located "outside the footprint of SWMU9." Noteworthy is the fact that this well is hydraulically downgradient of Combined SWMU 9 and therefore, any contaminants identified in this well should be attributed to the unit. This rationale should be applied at all monitoring locations in a hydraulically downgradient location. One result may be the need

to extend groundwater use restrictions to incorporate those parcels of land hydraulically downgradient that may be adversely impacted by a release from Combined SWMU 9 Landfill. Another result is the need to monitor wells that are outside the unit boundary.

CH2M-Jones Response:

We agree with the rationale that wells downgradient from the landfill should be monitored. Figure 5-3 of the CMS Report, Revision 0, proposed a network of monitoring wells suitable for monitoring groundwater quality near the landfill boundary. These wells were chosen based on the suitability of their location to detect contaminant migration from the landfill, should such migration occur. As discussed in the responses to several comments herein, it is likely that some additional wells (new or existing) should be added to this figure and some proposed wells in Figure 5-3 deleted. It may be most efficient to complete the identification of additional well locations in a meeting or conference call.

We also agree that LUCs should be applied to downgradient areas that are found to be adversely impacted by contaminants.

With respect to the example of arsenic concentrations in well H009GW24D, which is downgradient of the SWMU 9 landfill boundary, this deep well also showed an elevated detection of iron at 29,200 µg/L, indicating that arsenic concentrations in the deep zone could be occurring as a result of iron-reducing conditions. At other locations at the CNC, arsenic concentrations above its MCL and iron concentrations greater than 1,000 µg/L have been concurrently found, indicating natural iron-reducing conditions in the aquifer. Based on these similar observances of elevated arsenic and iron, , this detection of arsenic in deep groundwater cannot be concluded to be a result of a release of contamination and it is likely of natural geochemical origin.

3. Another concern is that for some parameters (i.e., arsenic) the concentrations are compared to Zone G background, while the concentration of other parameters (i.e., barium, manganese) is compared to Zone H background. Only two wells have been identified as background wells in Zone G and one of those (GGDGGw001, 01D) is located within Combined SWMU 9 Landfill. Eleven wells were identified in Zone H, thereby enhancing the dataset. In reality, concentrations should be compared to the background values from both Zone G and Zone H as the unit is spread over portions of each.

CH2M-Jones Response:

We agree that background concentration ranges from both Zone H and Zone G are appropriate for screening comparisons. This information will be reflected in revised text and tables in Revision 1 of the CMS Report for Combined SWMU 9.

4. A concern is that the text often states that a particular parameter was detected in certain shallow or deep wells and there is no discussion regarding the spatial and/or hydraulic relationship between the wells. For example, the text states that thallium was detected in the three deep monitoring wells H009GW02D, H009GW04D and H009GW07D. However, any hydraulic relationship among these wells has not been discussed. Throughout the text the Navy should state whether the wells in which contaminants are detected are in proximity and/or have a potential for hydraulic connection.

CH2M-Jones Response:

The three wells identified in the comment are significantly far apart from each other; the distance between H009GW02D and H009GW04D is about 1,500 feet, and the distance between H009GW04D and H009GW07D is about 2,300 feet. Because of the large distances between these wells, it is unlikely that there is a hydraulic or other relationship between these detections and the text will be clarified to indicate this.

A brief discussion of potential spatial or hydraulic relationships will be included for groundwater COCs that have detections in multiple wells and where these wells are located reasonably close to each other.

Constituents of Concern

5. On referenced Table 2-6, the Navy has given the Region III Tap Water RBC value for dibenzofuran as 24 µg/L. It is evident that this value has not been divided by 10 in order to bring the hazard index equal to 0.1 for a non-carcinogen. Dibenzofuran was detected in monitoring well G637GW003 three times in 1997 and once in 1998. The concentration of dibenzofuran was reported as 26J µg/L, 24= µg/L, 12J µg/L and 12= µg/L. Note that the "J" qualifier represents an estimated concentration while the "=" sign represents a quantifiable concentration. According to the data, dibenzofuran should be retained as a constituent of concern in shallow groundwater.

CH2M-Jones Response:

The text and table will be revised to indicate the tap water RBC value at a HI = 0.1. An evaluation will be made of the target organs affected by dibenzofuran, and dibenzofuran will be added to the list of COCs if an exceedance is indicated from the detected values.

6. According to Table 2-6, antimony was detected in concentrations greater than the MCL in four shallow monitoring wells from 1995 to 1999. Antimony was not detected in Zone H background wells and was detected at a maximum concentration of 6 µg/L in the Zone G background wells. The concentration range of antimony for the Combined SWMU 9 monitoring wells is from 1.6 µg/L to 45.6 µg/L. In monitoring wells G637GW003 and H009GW016, the concentration of antimony decreased through time while the concentrations increased in H009GW024 and G706GW001. The concentration of antimony in the latter two wells exceed the MCL of 6 µg/L. Based on this 1998 and 1999 data, antimony should be retained as a constituent of concern.

CH2M-Jones Response:

At H009GW024, the two exceedances of the MCL of 6 mg/L were succeeded by a detection below laboratory detection limits in the sample collected during January 2003, after this report was submitted. A detailed discussion of groundwater concentrations of COPCs and COCs at AOC 706 was discussed in the AOC 706 RFI Report Addendum/CMS Work Plan *(CH2M-Jones 2003). At G706GW001, the 1998 and 1999 detections were preceded by one detection below the MCL and two detections below laboratory detection limits. This information will be included in Revision 1 of the CMS Report for Combined SWMU 9. Antimony will be retained as a groundwater COC.*

7. According to Table 2-6, the concentrations of 2-Methylphenol (o-Cresol) indicate instability in monitoring well H009GW007 at concentrations of 270 µg/L, 71 µg/L, 390 µg/L and 79 µg/L (11/94-3/96). 2-Methylphenol (o-Cresol) should be retained as a constituent of concern in that two of the four detections exceed the Region III tap water RBC of 180 µg/L.

CH2M-Jones Response:

2-Methylphenol will be added to the shallow groundwater COC list because of the detections in H009GW007. The text and tables will be revised to reflect this information.

Constituents of Concern at the Unit Boundary in Concentrations Greater Than the MCL

8. While the Division of Hydrogeology can agree that continued in-situ containment of waste at Combined SWMU 9 is appropriate, the Division does not agree with the conclusion that groundwater data indicates there are no unacceptable human health or ecological exposure risks based on existing land use (industrial). Volatile organic and semi-volatile organic compounds plus arsenic, barium and lead have been detected in groundwater at Combined SWMU 9 in concentrations that exceed their respective MCLs/RBCs.

The Navy states that a primary objective will be to prevent the migration of contaminated groundwater from Combined SWMU 9. There are two parameters that exceed their respective MCLs in shallow monitoring wells located at or near the Combined SWMU 9 boundary. Chlorobenzene has recently been detected in H009GW014 at 140 µg/L as discussed in Comment 2 and according to the GIS database, barium is reported above its MCL of 2,000 µg/L as follows:

Sampling Dates	H009GW027	G637GW003	G706GW001	H009GW005 Background	H009GW008 Background
11/2-28/94				43.6 J	248 =
4/19-25/95				64.7 U	480 =
9/28/95				51.3 U	159 J
4/8-10/96				87.10 U	122 U
4/30/97		6,740 J	539 =		
9/14-15/97		4,640 J	422 J		
12/10-12/97		2,750 J	299 J		
2/12/98		46.3 =	1,440 =		
8/12/98	21,300				
7/27/99			2,290 =		
6/20/02				78.0 J	540 =
9/5-9/02				65.0 J	400 =

Note: "J" represents an estimated value; "U" represents non-detect/detection limit; and "=" represents quantifiable concentration.

Wells G706GW001 and G637GW003 are at the northwestern boundary of Combined SWMU 9. The Navy should add monitoring well H009GW027 to the routine sampling in order to provide sufficient data to determine whether this well is located in or near a source point. The Navy must take steps to either extend the groundwater use restrictions beyond the Combined SWMU 9 boundary to incorporate all parcels of land that could be impacted by contaminated groundwater emanating from Combined SWMU 9 or propose alternate stabilization/remedial activities.

CH2M-Jones Response:

No exposures of human or ecological receptors are occurring at Combined SWMU 9 that pose an unacceptable risk to human health or the environment. No human receptors are drinking the groundwater at the site. No unacceptable ecological exposures are occurring.

The detections of barium in G706GW001 and of chlorobenzene in well H009GW014 do not consistently (or during their most recent sampling) exceed their respective MCLs. At G706GW001, four additional samples have been collected since the last barium detection of 2,279 μg/L (from July 1999) shown in Table 2-6 of the CMS Report, Revision 0,, and in the table above. These four succeeding barium detections were 2,300 μg/L, 810 μg/L, 1,500 μg/L and 1,080 μg/L, in samples collected during June 2002, July 2002, September 2002, and January 2003, respectively. This additional information may be included in the text and tables of Revision 1 of the CMS Report for Combined SWMU 9. Seven out of nine historical detections of barium have been below the MCL of 2,000 μg/L in this well, indicating that although barium is present in the groundwater in this well, it does not pose a threat to groundwater quality. However, barium has been retained as a groundwater COC and will be periodically monitored. Additionally, the landfill boundary is being proposed to include AOC 706 (see response to Comment 10b from Jerry Stamps), and this well will now be considered to be within the landfill. An evaluation will be made to consider alternate existing or new wells north of AOC 706 to act as perimeter wells in this area.

The detections of chlorobenzene in well H009GW014 at 140 μg /L was preceded by six detections below the MCL and succeeded by two detections below the MCL of 100 μg /L. This single exceedance of the MCL at H014GW014 does not indicate that a plume capable of causing unacceptable impacts to ecological receptors is leaving the landfill boundary.

With regard to sampling well H009GW027, this well is located approximately 225 feet from the closest landfill boundary, well within the landfill footprint. Monitoring this well will not provide useful information regarding groundwater conditions at the landfill boundary; therefore, there is no reason to monitor this well. Other monitoring wells in the vicinity of well H009GW027 (within approximately 100 feet) also do not show elevated barium concentrations in groundwater, indicating that a significant barium plume is not present.

We agree that groundwater use restrictions should be extended downgradient of the landfill boundary where monitoring data indicate potential groundwater impacts may be occurring.

Hot Spot Treatment / Remediation

1. The Navy has only considered the unacceptable risk associated with direct contact with contaminants. The Navy has not considered potential subsurface areas that source a continuing release of contaminants to groundwater. For instance, the elevated concentration of barium in groundwater (21,300 µg/L) in the vicinity of SWMU 20 and the consistently elevated concentrations of barium in proximity to AOC 706 (4,000 µg/L and 2,290 µg/L) leads one to question whether there are isolated subsurface sources that should be considered for treatment. The GIS has no subsurface soil data for boring H009SB007193 at the monitoring well H009GW027 location. However, numerous surface soil and subsurface soil samples were collected from the AOC 706 vicinity. According to the GIS, the maximum concentration of barium in surface soil (6.7 mg/kg to 208 mg/kg) at AOC 706 exceeds the Zone H background maximum value of 73 mg/kg and the Zone G maximum value of 129 mg/kg. Also, the concentration of barium in subsurface soil from the AOC 706 location is 325 mg/kg. This value exceeds the maximum subsurface background concentrations for Zone G (7 mg/kg) and the maximum subsurface background concentration of 58 mg/kg for Zone H.

The GIS database for AOC 706 includes Synthetic Precipitation Leaching Procedure (SPLP) data, which should be discussed with regard to groundwater quality. There is a real possibility that the soils in this area (and possibly upgradient) are a continuing source of barium to groundwater. It may be possible to treat potential source areas and thereby reduce the continuing source to groundwater. The Navy should address barium at the SWMU 20 and AOC 706 areas.

CH2M-Jones Response:

This comment appears to address the risk assessment methodology used for the Zone H RFI Report, Revision 0 *(EnSafe, 1996) and the COPC screening and COC identification used in* RFI Report Addendum/CMS Work Plan for AOC 706 *(CH2M-Jones, May 2003), rather than the CMS Report, Revision 0. In the Zone H RFI report, the risk assessment focused on surface soil risk and groundwater. This approach for completing the SWMU 9 risk assessment was made by the BCT at that time and there does not appear to be a reason to retract that approach now. No subsurface soil COCs were identified in the Zone H RFI report for Combined SWMU 9 in the risk assessment.*

Surface and subsurface soil COCs for AOC 706 were evaluated in the AOC 706 RFI Report Addendum as agreed to by the BCT (per the CNC Project Notebook). The reviewer notes above that barium in a surface soil sample at AOC 706 was 208 mg/kg and that this value exceeds the Zone H and G background values. However, it should be noted that this value is below the residential RBC (HI = 0.1) of 550 mg/kg and also below the generic SSL (DAF = 10) of 800 mg/kg. All other barium results for surface soil were below these values. Therefore, barium in surface soil would not be considered a COPC for either the residential or industrial land use scenarios.

Similarly, the subsurface soil concentration noted above for a sample at AOC 706 of 325 mg/kg is also well below the generic SSL value (DAF = 10) of 800 mg/kg. All other subsurface soil samples also had barium concentrations below this value. Barium was not identified as a soil COC at AOC 706 since the soil concentrations do not indicate its presence *at significant concentrations. There are no indications that the soil at AOC 706 is a leaching source for barium. Also, in the last three groundwater sampling events, barium concentrations have been below the MCL, indicating that a significant barium plume is not present.*

The evaluation of the remedy for Combined SWMU 9 is in accordance with EPA's presumptive remedy for solid waste landfills. It is not the intent of the presumptive remedy (leaving the waste in place) to require treatment of in situ buried waste The presumptive remedy addresses direct exposure to surface soils and potential impacts of groundwater leaving the landfill boundaries. This is especially important to note since the contents of the landfill are diverse and their exact disposition within the landfill are unknown.

While it is possible for the landfill waste to be contributing to the presence of various chemicals in the groundwater, since a significant portion of the landfill waste was originally deposited in the landfill below the water table, this condition is not of concern unless it is determined that groundwater COCs are migrating from the landfill boundary at concentrations that pose an unacceptable risk to human health or the environment.

Groundwater Remedial Action Contingency Plan

2. The Navy must address the two contaminants, chlorobenzene and barium, that have been detected at the Combined SWMU 9 boundary in concentrations that exceed their respective MCLs. The Navy must determine whether source control measures beyond the proposed cap are necessary, the type of action that would be appropriate at the source, and propose measures to actively control offsite migration of contaminated groundwater. In other words, this CMS Report must include a remedial action contingency plan to be implemented to address inorganics and VOCs/SVOCs in groundwater in concentrations greater than acceptable standards at the boundary of the unit. See Comments 2 and 11.

CH2M-Jones Response:

There is currently no indication that concentrations of chlorobenzene in groundwater or in Shipyard Creek warrant a need to conduct active control of offsite migration of chlorobenzene. The levels of chlorobenzene seen in well H009GW014 are generally below the MCL, as well as below the EPA Region IV saltwater chronic toxicity value of 105 μg/L.

Based on these observations, there is no unacceptable risk to Shipyard Creek from the chlorobenzene concentrations detected in the perimeter wells at SWMU 9, and no remedial actions to address the detected exceedances of chlorobenzene in groundwater are warranted.

With respect to barium exceedances in groundwater, please also see the response to Comment 1 from Jo Cherie Overcash under Hot Spot Treatment/Remediation. The landfill boundary is being proposed to include AOC 706 (see response to Comment 10b from Jerry Stamps), and the well G706GW001 with previously elevated barium detections will now be considered to be within the landfill. Barium concentrations in this well during the past three sampling events have been below the drinking water MCL of 2,000 ug/L. An additional monitoring well or wells north of AOC 706 will be identified to act as a perimeter well(s) in this area. No source control measures for barium are currently warranted, since there are no data to indicate that barium concentrations in excess of the MCL are migrating from the proposed landfill boundary on the northwest side of SWMU 9.

Based on discussions with SCDHEC at the September 2003 BCT meeting, we will develop a remedial contingency action plan for SWMU 9 for the revised CMS report.

Continued Groundwater Monitoring – Sections 3.4.3; 4.3.2.5; and 5.4.2

3. The Navy refers to "compliance wells" located downgradient of Combined SWMU 9 and has proposed a monitoring network on Table 3-1 entitled COCs in Perimeter Wells. However, a number of these wells are located at Shipyard Creek (H009GW001, 01D, 004, 013, 014, 024). It is inappropriate to locate "compliance wells" at the groundwater/surface water discharge point. Compliance wells must be located near the unit boundary. The purpose of the compliance wells is to monitor groundwater plume movement and to alert the Navy and the Department of imminent concerns. Compliance wells must be located a sufficient distance from the discharge point to surface water bodies in order to allow time for implementation of a contingent remedial action, should one be necessary. The Navy must incorporate compliance wells (sentinel wells) at the boundary of Combined SWMU 9 Landfill into the monitoring network. The monitoring locations along Shipyard Creek should be retained for purposes of the Environmental Indicators and the Bureau of Water's annual groundwater inventory.

CH2M-Jones Response:

We agree that alternate monitoring locations should be considered in the southwestern portion of the landfill. We propose that wells H009GW025 and H009GW026 be used as monitoring wells for this purpose, in addition or as replacement for some of the wells along Tidewater Road and added to the list of wells monitored annually.

4. The Navy has not listed any wells on Table 3-1 to monitor shallow groundwater plume movement in the northeast quadrant nor any wells at the northwest corner at Hobson Avenue. Additional monitoring locations must be identified.

CH2M-Jones Response:

We propose that wells H009GW005 and H009GW011 on the northeast side of SWMU 9 be added to Table 3-1 and included in the periodic monitoring.

In the area northwest of SWMU 9, there are several wells in the vicinity of Building 224 that may be suitable for use as monitoring locations. There are also several FDS (Fuel Distribution Systems) wells located northwest of SWMU 9 that may be suitable. One or more of the wells in this area will be included in Table 3-1 in the revised CMS report.

5. Review of the data indicates that several monitoring wells should be added to the routine groundwater sampling event. Analysis for metals should be conducted in the following wells: H009GW027, H009GW009, H009GW016 and H009GW026D. Analysis for VOCs should be conducted in H637GW003, H009GW007, H009GW010.

CH2M-Jones Response:

CH2M-Jones is committed to performing adequate monitoring of the landfill to ensure that migration of a plume that could cause unacceptable adverse impacts does not occur. We have proposed including several additional monitoring locations in these responses to comments. However, many of the wells proposed for monitoring in the above comment are located within *the interior of the landfill. We do not believe that there is a reason to perform routine monitoring of wells located within the landfill interior, since they will not provide data useful for determining whether a release from the landfill perimeter is occurring.*

Surface Water Quality – Shipyard Creek and the Cooper River

6. In section 3.4.4. Surface Water, the Navy states that there are "currently no human receptors using the surface water in either Shipyard Creek or Cooper River, making the exposure pathway incomplete at the present time." The ecological risk and the surface water quality standard for Shipyard Creek and the Cooper River must be considered. The Navy must demonstrate that discharge of contaminated groundwater to Shipyard Creek does not contravene surface water standards and does not pose an ecological threat.

According to R.61-69 Classified Waters, that portion of the Cooper River that passes along the CNC has the surface water designation Class SB. Groundwater discharge into the Cooper River from CNC must not contravene the Class SB standard. See Section G of R.61-68 for a full explanation.

CH2M-Jones Response:

We agree that concentrations of concern with regard to groundwater contaminants discharging into Shipyard Creek or the Cooper River should be based on ecological criteria rather than drinking water MCLs, since no human receptors are drinking these surface waters. As indicated in Section 3.4.4, surface water monitoring to date has not indicated detectable levels of any of the constituents detected at SWMU 9.

Additional information on ecological risk to Shipyard Creek from the SWMU 9 area has been detailed in Section 7.0 of the Zone H RFI Report, Revision 0 *(EnSafe, 1996), which does not identify ecological risks to Shipyard Creek from the COPCs detected in soil and groundwater in Combined SWMU 9.*

Based on these observations, additional demonstration of a lack of adverse impacts to Shipyard Creek from SWMU 9 is not warranted at this time.

Specific Comments

2.1 Combined SWMU 9 Boundary

7. Reference is made to solid waste management unit (SWMU) 8 Oil Sludge Pit at the Parking Area Southwest of Building 61 and to area of concern (AOC) 654 Septic Tank and Drain Field Building 661 Area. The Navy should identify these units on Figure 2-1 entitled Combined SWMU 9 Estimated Landfill Boundary.

CH2M-Jones Response:

Figure 2-1 will be revised to identify these units.

8. The Landfill boundary depicted on Appendix A Figure 1-2 does not match the boundary depicted on CMS Report Figure 2-1 entitled Combined SWMU 9 Estimated Landfill Boundary. Clarification of the unit boundary is needed.

CH2M-Jones Response:

Figure 1-2 shown in Appendix A is being included as a reference to indicate the location of the test pits excavated by the Navy DET as part of the determination of the northern boundary of the landfill, whereas Figure 2-1 indicates the northern boundary proposed by the SWMU 9 CMS Report, Revision 0. The text in Appendix A will be revised to reflect this information, and Figure 1-2 in Appendix A will be noted to be consistent with Figure 2-1. The current estimated northern boundary of the landfill, based on the consensus opinion of the BCT, is shown in Figure 2-1.

2.2 Combined SWMU 9 Background and Figure 2-2 SWMU 9 Land Use

9. The text is vague in describing the "current" land use. The Navy states that a deed restriction will limit future development or land use to the "current uses". Moreover, referenced Figure 2-2 simply identifies three baseball fields, the running track, building pads and occupied Buildings 0672 and 0673. It is unclear whether the "Light Industrial" label on this Figure given outside the boundary east of the Landfill also applies to SWMU 9. The text should clearly state the intended reuse of this property and explain "limiting future development".

CH2M-Jones Response:

Figure 2-2 will be revised to clarify the proposed land use zoning as it applies to Combined SWMU 9. The CNC EGIS (version 10.0) shows the various zoning codes. The Combined SWMU 9 boundary is included in the zone M-1 (marine light industrial). Please refer to the CNC Redevelopment Plan for additional information on the land use zones in this area.

The baseball fields have not been used for several years and are not maintained. The running track is reportedly used by the U.S. Border Patrol for personnel training and conditioning. Buildings 672 and 673 are used by Sanitech Environmental, Inc. The future land use may include a variety of uses depending on the level of development that a future land owner chooses to make. It would be impossible to accurately speculate at this time as to what the entire universe of those land uses could include. Land use restrictions may limit specific land uses that could compromise the protectiveness of the corrective measures.

2.2.4 AOC 637 - Former Burning Dump

10. Reference is made to AOC 636 Torpedo Magazine at Building 161. Please depict the site on Figure 2-1.

CH2M-Jones Response:

Figure 2-1 will be revised to identify the AOC 636 location.

2.2.6 Combined SWMU 9 Groundwater

11. The potentiometric maps included in this CMS Report only provide a snapshot in time (6/2/02). Of interest is whether the direction of groundwater flow is consistent through time or is altered by drought conditions. Historical groundwater elevation data should be provided in tabular form along with infiltration rates.

CH2M-Jones Response:

The historical groundwater elevation information has been provided in Appendix C of the Zone H RFI Report, Revision 0, for the wells sampled during the Zone H RFI. Historical RFI and recent groundwater elevation measurements can be tabulated and provided in Revision 1 of the CMS Report for Combined SWMU 9. Infiltration rates are being evaluated as part of a response to a comment by Jerry Stamps.

12. The Navy states that groundwater was encountered at ground surface in the marsh areas. The referenced marsh areas must be depicted on a map.

CH2M-Jones Response:

This information will be included in Revision 1 of the CMS Report for Combined SWMU 9.

13. The entirety of Combined SWMU 9 must be depicted on Figure 2-8 entitled Potentiometric Surface Map – Shallow Groundwater.

CH2M-Jones Response:

Figure 2-8 will be revised to include the entire footprint of Combined SWMU 9 at a larger scale.

14. The relationship between Combined SWMU 9 and the Cooper River and the relationship between the unit and Shipyard Creek must be clearly depicted on a figure of sufficient scale and in cross section(s).

CH2M-Jones Response:

Please refer to Figures 3.3 and 3.4 of the Zone H RFI Report, Revision 0 which shows lithologic cross sections running the north-south and east-west through the Combined SWMU 9 boundary. A copy of these figures can be included in an appendix to Revision 1 of the CMS Report for Combined SWMU 9.

15. The referenced "...aquitard that impedes flow between the sand units" must be fully characterized and the extent of this unit depicted on the cross section(s). See correspondence Scaturo to Daniell, dated September 27, 2001.

CH2M-Jones Response:

This characterization of the lithology was derived from previous investigations conducted as part of the Zone H RFI. An attempt will be made to locate results of soil core sampling conducted as part of the Zone H RFI, and available information will be provided to illustrate the lithology in this area.

16. Also, the text should be revised to more accurately and more clearly explain the direction of shallow groundwater flow. For example, the text states "groundwater flow in the central portion of SWMU 9 forms a trough that appears to flow to the north/northeast towards the Cooper River." The referenced "trough" is not evident from Figure 2-8. Another example: the text states that groundwater flow in the southeastern portion of SWMU 9 "flows radially to the north, west and south." The referenced southern component of flow cannot be deduced from Figure 2-8.

CH2M-Jones Response:

Figure 2-8 will be revised to include additional groundwater elevation contours to illustrate the description made in the text of the groundwater flow at Combined SWMU 9.

17. Deep groundwater flow in the northwestern portion of Combined SWMU 9 must be depicted on Figure 2-9 entitled Potentiometric Surface Map – Deep Groundwater.

CH2M-Jones Response:

Deep well contours will be provided in Revision 1 of the CMS Report for Combined SWMU 9.

2.2.7.1 SWMU 9

18. The text references 11 trenches that were excavated during the RFI activities in addition to the test pit excavations performed by the Environmental Detachment Charleston (DET). The Navy should depict the 11 trenches on a map and identify the contents of each.

CH2M-Jones Response:

Figure 4.1.1 of the Zone H RFI Report, Revision 0 *(EnSafe, 1997) shows the locations of the 11 trenches. A copy of this figure will be included in Revision 1 of the CMS Report for Combined SWMU 9.*

2.2.7 Nature and Extent of Contamination

19. The referenced subsurface soil data for SWMU 19, SWMU 20 and SWMU 121 is not presented in the associated tables nor discussed in the text. The facility's GIS database does not include subsurface soil data for SWMU 20 and only includes data from one subsurface location at SWMU 121 and data from two locations at SWMU 19. Note that lead is reported in the GIS database in subsurface soil location H121SB007 at a concentration of 508 milligrams per kilogram (mg/kg). Of specific concern is whether a release to subsurface soil has an affect on groundwater quality. Clarification is needed as to whether the RFI identified any subsurface soil parameters, and if so, whether groundwater quality has been impacted.

CH2M-Jones Response:

Section 2.2.7 of the CMS Report, Revision 0, summarizes the soil COCs identified in the Zone H RFI Report, Revision 0. Detailed information of subsurface soil data is presented in the Zone H RFI Report, Revision 0. As indicated in the Zone H RFI Report, many of the subsurface soil samples proposed for collection were not collected during the RFI, due to the shallow depth of groundwater encountered. The Zone H RFI Report did not identify any surface soil COCs at Combined SWMU 9.

With respect to the lead detection in subsurface soil at H121SB007 (which is approximately 150 feet inside the landfill boundary) and its impact on the groundwater, this detection could be the result of buried waste. It is not the intent of this CMS to evaluate localized groundwater impacts from buried landfill waste. Additional text will be added in Revision 1 *of the CMS Report for Combined SWMU 9 to clarify the reasons for the lack of subsurface soil sampling at Combined SWMU 9 sites.*

Since the specific nature of the landfill waste at various locations is unknown, it would be impossible to indicate a linkage between the groundwater quality and the subsurface soil COPCs detected during the RFI.

2.2.7.8 Combined SWMU 9 Groundwater

20. Groundwater monitoring results for samples collected from SWMU 20 monitoring wells H20TGW00005, 004 and 007 and from SWMU 121 monitoring wells H121TWGW001, H121GWTW02, 03, and 04 are not provided in the facility's geographic information system (GIS). Neither are these sample results included in Appendix E entitled Chemical Detected in Zone H Monitoring Wells of the September 30, 1997, Final RFI Report for Zone H Addendum. Please provide the analytical data or reference where this data can be found. Also, the Navy should clarify whether this data was considered during preparation of the list of constituents of potential concern/constituents of concern.

CH2M-Jones Response:

The "T" designation for these wells indicates that the wells were temporary wells and the analytical results may be of limited quality or unvalidated. These wells have been abandoned. The data will be requested from the Navy/EnSafe team and, if available, provided in the revised CMS report.

3.4.3 Groundwater - Typographical Error

21. In order to be consistent with the RCRA Corrective Action Project Team Notebook, the risk based concentrations (RBCs) should be taken from US EPA Region III RBC Table, dated October 2000, not Region IX.

CH2M-Jones Response:

The text in line 26, page 3-4 will be revised to state that the EPA Region III RBCs were used during the COPC screening.

4.2 Presumptive Remedy Evaluation

22. In subsection 4.2.1 entitled Collect Available Information and subsection 4.2.3 entitled Landfill Contents, the Navy fails to state that hazardous waste was disposed in Combined SWMU 9. While the majority of the waste contained in Combined SWMU 9 is reported to be non-hazardous in that it is domestic waste, construction and demolition debris and yard trash, the CMS Report must also state that SWMU 121 included a satellite accumulation area for hazardous waste and that there was no secondary containment at this facility during those activities. See Section 2.2.3 of this CMS Report.

CH2M-Jones Response:

Text in subsection 4.2.1 will be edited to be consistent with text in Section 2.2.3

Appendix A Figure 1-2 Combined SWMU 9 Boundary

23. The title should be changed to clarify that Figure 1-2 is of the "Northern" boundary.

CH2M-Jones Response:

Figure 1-2 was derived from the Navy DET's IM Completion Report. The original copy of this figure appears to have been a color copy. If an original color version of this figure can be located, color copies will be provided. It is likely that SCDHEC already has an original copy of this material in its files.

24. The legend contains symbols that are not distinct enough to depict the information. The legend should be revised.

CH2M-Jones Response:

Figure 1-2 was derived from the Navy DET's IM Completion Report. The original copy of this figure appears to have been a color copy. If an original color version of this figure can be located, color copies will be provided. It is likely that SCDHEC already has an original copy of this material in its files.

25. The legend has the same symbol for "84 Foreign material found in excavation" and "84 Foreign material not found in excavation." Another symbol should be employed.

CH2M-Jones Response:

Figure 1-2 was derived from the Navy DET's IM Completion Report. The original copy of this figure appears to have been a color copy. If an original color version of this figure can be located, color copies will be provided. It is likely that SCDHEC already has an original copy of this material in its files.

26. The legend does not describe the symbol used in the vicinity of SWMU 20/Building 0903. Clarification is needed.

CH2M-Jones Response:

Figure 1-2 was derived from the Navy DET's IM Completion Report. The original copy of this figure appears to have been a color copy. If an original color version of this figure can be located, color copies will be provided. It is likely that SCDHEC already has an original copy of this material in its files.

27. Clarify whether Test Pit #1 is depicted as "A" and Test Pit #60 is depicted as "P".

CH2M-Jones Response:

This appears to be the case. As indicated in Table A of the Navy DET's IM Completion Report included in Appendix A, test pits #1 and #60 could not be advanced due to their location along Bainbridge Avenue

28. The Landfill boundary depicted on this Figure does not match the boundary depicted on CMS Report Figure 2-1 entitled Combined SWMU 9 Estimated Landfill Boundary. Clarification of the boundary should be provided.

CH2M-Jones Response:

The text in Appendix A will be revised to clarify that the landfill boundary shown in Figure 1-2 was estimated at the conclusion of the DET IM, and that the current proposed boundary, per the BCT consensus opinion, is the one shown in Figure 2-1.

Figure 2-11 Combined SWMU 9 Monitoring Wells

29. The Navy should provide a larger scale map in order to depict the monitoring wells more distinctly. This Figure is crucial throughout this review.

CH2M-Jones Response:

Figure 2-11 will be reproduced at a larger scale and included in Revision 1 of the CMS Report for Combined SWMU 9.