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CORRECTIVE MEASURES STUDY REPORT COMBINED SOLID WASTE MANAGEMENT UNIT 5 (SWMU 5) ZONE E CNC CHARLESTON SC

12/23/2003

CH2M HILL

CORRECTIVE MEASURES STUDY REPORT

Combined SWMU 5, Zone E

Charleston Naval Complex
North Charleston, South Carolina

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

CH2M Jones

December 2003

Contract N62467-99-C-0960

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CH2MHILL

December 23, 2003

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

Re: CMS Report (Revision 0) – Combined SWMU 5, Zone E

Dear Mr. Scaturo:

Enclosed please find two copies of the CMS Report (Revision 0) for Combined SWMU 5 in Zone E of the Charleston Naval Complex (CNC). This report has been prepared pursuant to agreements by the CNC BRAC Cleanup Team for completing the RCRA Corrective Action process.

Please contact me at 352/335-5877, ext. 2280, if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

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

CORRECTIVE MEASURES STUDY REPORT

Combined SWMU 5, Zone E

Charleston Naval Complex
North Charleston, South Carolina

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

PREPARED BY
CH2M-Jones

December 2003

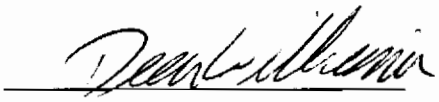
Revision 0
Contract N62467-99-C-0960
158814.ZE.EX.26

Certification Page for Corrective Measures Study Report (Revision 0) — Combined SWMU 5, Zone E

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, P.E.

12/17/2013

Date

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Acronyms and Abbreviations

AOC	area of concern
BEQ	benzo(a)pyrene equivalent
BRAC	Base Realignment and Closure Act
CA	corrective action
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
CVOC	chlorinated volatile organic compound
DET	Environmental Detachment Charleston
DO	dissolved oxygen
EnSafe	EnSafe Inc.
EPA	U.S. Environmental Protection Agency
ft bls	feet below land surface
ft msl	feet above mean sea level
HI	hazard index
ILCR	Incremental Lifetime Cancer Risk
IM	interim measure
IMCR	interim measure completion report
LUC	land use control
LUCIP	land use control implementation plan
LUCMP	land use control management plan
MCL	maximum contaminant level
MCS	media cleanup standard
µg/L	microgram per liter
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
NAVBASE	Naval Base
ORP	oxidation reduction potential

Acronyms and Abbreviations, Continued

OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDA	Redevelopment Authority
RFI	RCRA Facility Investigation
RI	remedial investigation
RGO	remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SWMU	solid waste management unit
TTL	target treatment level

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.

A RCRA Facility Investigation (RFI) Report Addendum, Interim Measure Completion Report (IMCR), and Corrective Measures Study (CMS) Work Plan were prepared for Solid Waste Management Units (SWMUs) 5 and 18 and Areas of Concern (AOCs) 605 and 621 in Zone E of CNC. These units were investigated together during the RFI due to their proximity and will be referred to as Combined SWMU 5 in this report. Combined SWMU 5 is located in the industrial area of Zone E between Pierside Street and Dry Dock No. 4. Figure 1-1 illustrates the locations of the sites within the CNC. Figure 1-2 is an aerial photograph of the area.

The RFI Report Addendum, IMCR, and CMS Work Plan presented the remedial action objectives (RAOs) and media cleanup standards (MCSs) proposed for Combined SWMU 5, and the RFI Report Addendum and CMS Work Plan report was approved by SCDHEC in August 2003. This CMS report has been prepared by CH2M-Jones to complete the next stage of the CA process for Combined SWMU 5.

1.1 Corrective Measures Study Report Purpose and Scope

This CMS report evaluates corrective measure alternatives for polycyclic aromatic hydrocarbons (PAHs) in surface soil and lead in shallow groundwater at Combined SWMU 5. The report consists of: 1) the identification of a set of corrective measure alternatives that are considered to be technically appropriate for addressing groundwater contamination; 2)

an evaluation of the alternatives using standard criteria from U.S. Environmental Protection Agency (EPA) RCRA guidance; and 3) the selection of a recommended (preferred) corrective measure alternative for the site.

1.2 Background Information

This section of the CMS report presents background information on the facility, site history, and a summary of the nature and extent of the chemicals of concern (COCs) at the site. This information is essential to the understanding of the remedial goal options (RGOs), MCSs, and ultimately the evaluation of corrective measure alternatives for Combined SWMU 5. Additional information on the site and hydrogeology in the Zone E area of the CNC is provided in the *Zone E RFI Report, Revision 0* (EnSafe Inc. [EnSafe], 1997).

1.2.1 Facility Description and Site History

SWMU 5 is a former battery electrolyte treatment area adjacent to Pad 1278 and Dry Dock 4. Associated with battery salvaging, restoring, and recharging operations, this site was used to neutralize submarine battery acid from 1962 until 1985. It consisted of a battery disassembly platform, two neutralization tanks, and customized transporting railcars.

SWMU 18 is a former polychlorinated biphenyl (PCB) spill area at the Public Works Resource Recovery Facility Storage Area. In June 1987, a contractor was loading PCB-containing items when a transformer broke and discharged approximately 75 gallons of Pyranol insulating fluid onto the ground. Shortly thereafter soil excavation was conducted to remediate the spill.

AOC 605 is a waste paint storage area adjacent to Dry Dock 4 on Pad 1278. The 40-foot by 250-foot concrete pad was constructed in 1943 as a welding area. Since 1987, the pad has been used to store materials such as paints, used oils, solvents, and chemicals. The pad is bordered to the south and west by unpaved areas.

AOC 621 comprises the battery cracking area associated with SWMUs 5 and 18 and AOC 605. The unit is a concrete pad surrounded by a 1 foot-high concrete containment wall. AOC 621 was used as a welding slab from the early 1940s until around 1950. From the early 1950s to the mid-1970s, this work area was used for wrecking submarine batteries, with operations including cracking batteries and draining the acids to recover lead and container cells, which were sold for scrap. A collection sump drained acid from the pad to the neutralization facility. An adjacent crane was used to move batteries around the work area.

Concrete and asphalt pavement surrounded AOC 621, except for an area of soil and gravel to the southwest.

The area where Combined SWMU 5 is located is zoned M-2, heavy marine industrial use. The site is expected to be used for industrial use for the foreseeable future.

Combined SWMU 5 is recommended for an RFI in the current RCRA permit.

The RFI activities initially conducted by the Navy/EnSafe team were described in the *Zone E RFI Report, Revision 0* (EnSafe, 1997). Regulatory review was conducted on this document and draft responses to the comments from SCDHEC were prepared by the Navy/EnSafe team. Remaining issues related to the RFI phase of the CA program were addressed in the RFI Report Addendum (CH2M-Jones, 2003). RFI soil and groundwater sampling locations are shown in Figures 1-3 and 1-4, respectively.

Several interim measures (IMs) were conducted at Combined SWMU 5 to address contaminated soil. An IM to excavate and dispose of PCB-impacted soil was conducted in 1987 to address a spill of transformer insulating fluid. A total of 22 drums of contaminated soil plus an additional 22 tons of soil were excavated to address this spill.

The Navy's Environmental Detachment Charleston (DET) completed an IM at the site in 1997 and 1998 to address lead-impacted soil. Approximately 510 tons of lead-impacted soil were removed from the site and disposed of as a hazardous waste. A 1-foot thick layer of a soil/lime mixture was placed in the excavation prior to backfilling to neutralize residual acid that was present in the soil from releases from lead acid batteries handled at the site.

CH2M-Jones performed an additional IM in 2001 and 2002 to address lead-impacted soil. Approximately 460 tons of lead-impacted soil were removed from the site and the target cleanup objectives (to remediate the site to levels acceptable for continued industrial use) were achieved.

These IMs were described in more detail in the RFI Report Addendum (CH2M Jones 2003).

1.2.2 COC Summary

Based on the results of the sampling and analysis and evaluation of current contamination levels in the RFI Report Addendum, benzo(a)pyrene equivalents (BEQs) were identified as surface soil COCs for both the unrestricted and industrial land use scenario. Lead was also identified as a surface soil COC for the unrestricted land use scenario.

No subsurface soil COCs were identified for either the unrestricted or industrial land use scenario.

No groundwater COCs were identified for the site in the RFI Report Addendum. However, because of previous detections of lead in groundwater samples collected from one well at concentrations above its target treatment level (TTL) of 15 micrograms per liter (µg/L), the BCT agreed to conduct additional monitoring for lead and to assess potential remedial approaches for addressing lead in groundwater, should lead concentrations be determined to be present above the TTL.

1.3 Summary of Surface Soil Condition

The only COC remaining in surface soil at the site for the industrial land use scenario is PAH. PAH concentrations in surface soil at Combined SWMU 5 (expressed as BEQs) are above the sitewide reference concentration adopted by the BCT (1,304 micrograms per kilogram [µg/kg], as BEQs for surface soil) in only four samples (018SB00401, 1,650 µg/kg; 605SB004, 6,201 µg/kg; 605SB01301, 1,370 µg/kg; and 605SB01401, 1,350 µg/kg). The locations of these samples are shown in Figure 1-5.

Lead concentrations remaining in surface soil are below the target cleanup level for industrial use.

1.4 Summary of Groundwater Conditions

1.4.1 Summary of Hydrogeologic Setting at Combined SWMU 5

Surface Geology

Combined SWMU 5 is located in the southeastern portion of Zone E at the CNC. Elevations range between approximately 8 to 10 feet above mean sea level (ft msl). Due to the extensive surface soil disturbance at CNC during the history of its operations, the soils from land surface to depths of up to approximately 6 feet are typically a mixture of artificial fill and native sediments. The extent of fill material present varies extensively, but in the vicinity of Combined SWMU 5, undifferentiated clay, sand, gravel, dredged material, and construction debris may be present at or near the land surface. In undisturbed areas, surface deposits consist of Quaternary age (Holocene epoch to recent) fine-grained sands and clays typical of

a coastal plain environment, repeatedly reworked by marine and river water erosion prior to development by man.

Subsurface Geology

The Zone E RFI report included the installation of soil borings and more than 185 monitoring wells, from which geologic information was collected to develop geologic cross sections. The data indicate that Quaternary (Pleistocene to Holocene) and Tertiary age unconsolidated sediments were encountered in the subsurface. The lowermost unit encountered is the Tertiary age Ashley Formation member of the Mid-Tertiary age Cooper Group. Overlying the Ashley Formation are younger upper Tertiary and Quaternary age deposits, which are in turn overlain by the Holocene to recent surface soils.

In most of Zone E, including the area in which Combined SWMU 5 is located, the Ashley Formation is encountered in deeper borings, occurring at depths ranging from approximately 16 to 43 feet below land surface (ft bls). In this portion of Zone E, the top of the Ashley Formation is located approximately 30 ft bls, is gently rolling, and slopes gently downward to the east toward the Cooper River, with measured thickness approaching 40 feet. The Ashley Formation is comprised of brown to olive marine silts with varying amounts of clay, phosphatic sand and microfossils. The Ashley Formation's consistency is generally dense to stiff and plastic, with low vertical permeability. The overlying Quaternary age deposits are back barrier and near shore shelf deposits from various past marine transgressions, with subsequent reworking erosion and redeposition. The result is a sequence approximately 15 to 85 feet thick at the CNC and comprised mainly of Pleistocene age Wando Formation sands, silts, and clays, with varying amounts of organic matter, including peat.

At Combined SWMU 5, the boring logs for the monitoring wells indicate that the shallow aquifer geology consists of fill (consisting of gravel, sand, with some cobbles) underlain by interbedded sands and clay layers.

Hydrogeology

The shallow aquifer system at Combined SWMU 5 is an unconfined water table aquifer occurring within the Quaternary sediments. The Ashley Formation, located at

approximately -24 ft msl, acts as an aquitard for the shallow aquifer system and as a confining unit for deeper geologic units. The Cooper River acts as a regional discharge boundary for the aquifer to the east. The average saturated aquifer thickness in the Combined SWMU 5 area, based on the Zone E RFI Report, is approximately 25 feet.

Regionally in Zone E, the shallow groundwater flow direction is eastward, toward the Cooper River. Because a significant portion of Zone E is along the riverfront, the Cooper River is a major discharge boundary for the shallow aquifer system. Locally at Combined SWMU 5, groundwater flow is generally eastward, toward the Cooper River, as indicated in potentiometric surface map in Figure 1-6. Section 2.3.7 of the *Zone E RFI Report, Revision 0* (EnSafe, 1997) indicates that minimal tidal influence on groundwater elevations has been observed at Combined SWMU 5.

1.4.2 COC Distribution in Groundwater

Table 1-1 summarizes all groundwater analyses for lead at the site. It can be seen in the table that out of 30 total analyses for lead, only 5 exceeded the TTL of 15 $\mu g/L$. These exceedances occurred at a single location (where well E605GW002 was originally installed and in the replacement well, E605GW004, installed at the same location as E605GW002). These results indicate that impacts to groundwater at the site have been limited in extent. Figure 1-7 shows the location of the wells and exceedances.

As indicated in Table 1-1, lead exceedances have decreased significantly over time. The reasons for the decrease in these exceedances in groundwater are probably due to the extensive removal of lead-impacted soil in this area and to the placement of the soil/lime mixture in the area excavated by the DET. Lead was detected at, but not above, its TTL in the most recent sampling event for well E605GW004.

1.5 Overall Approach for Selecting Candidate Corrective Measure Alternatives for Combined SWMU 5

Because of the relatively small areal extent of impacted media at Combined SWMU 5, the list of practicable remedial alternatives for this site is limited.

Two remedies will be considered for the subsurface soil and groundwater in the CMS for Combined SWMU 5:

- Soil Excavation, Groundwater Monitoring, and land use controls (LUCs), and

- Groundwater Monitoring and LUCs.

1.6 Report Organization

This CMS report consists of the following sections, including this introductory section:

1.0 Introduction — Presents the purpose of and background information relating to this CMS report.

2.0 Remedial Goal Objectives and Evaluation Criteria— Defines the RGOs for Combined SWMU 5, in addition to the criteria used in evaluating the corrective measure alternatives for the site.

3.0 Description of Candidate Corrective Measure Alternatives — Describes each of the candidate corrective measure alternatives for COCs and the LUCs.

4.0 Evaluation and Comparison of Corrective Measure Alternatives — Evaluates each alternative relative to standard criteria, then compares the alternatives and the degree to which they meet or achieve the evaluation criteria.

5.0 Recommended Corrective Measure Alternative — Describes the preferred corrective measure alternative to achieve the MCS and RGOs for COCs based on a comparison of the alternatives.

6.0 References — Lists the references used in this document.

Appendix A contains cost estimates developed for the proposed corrective measure alternatives.

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

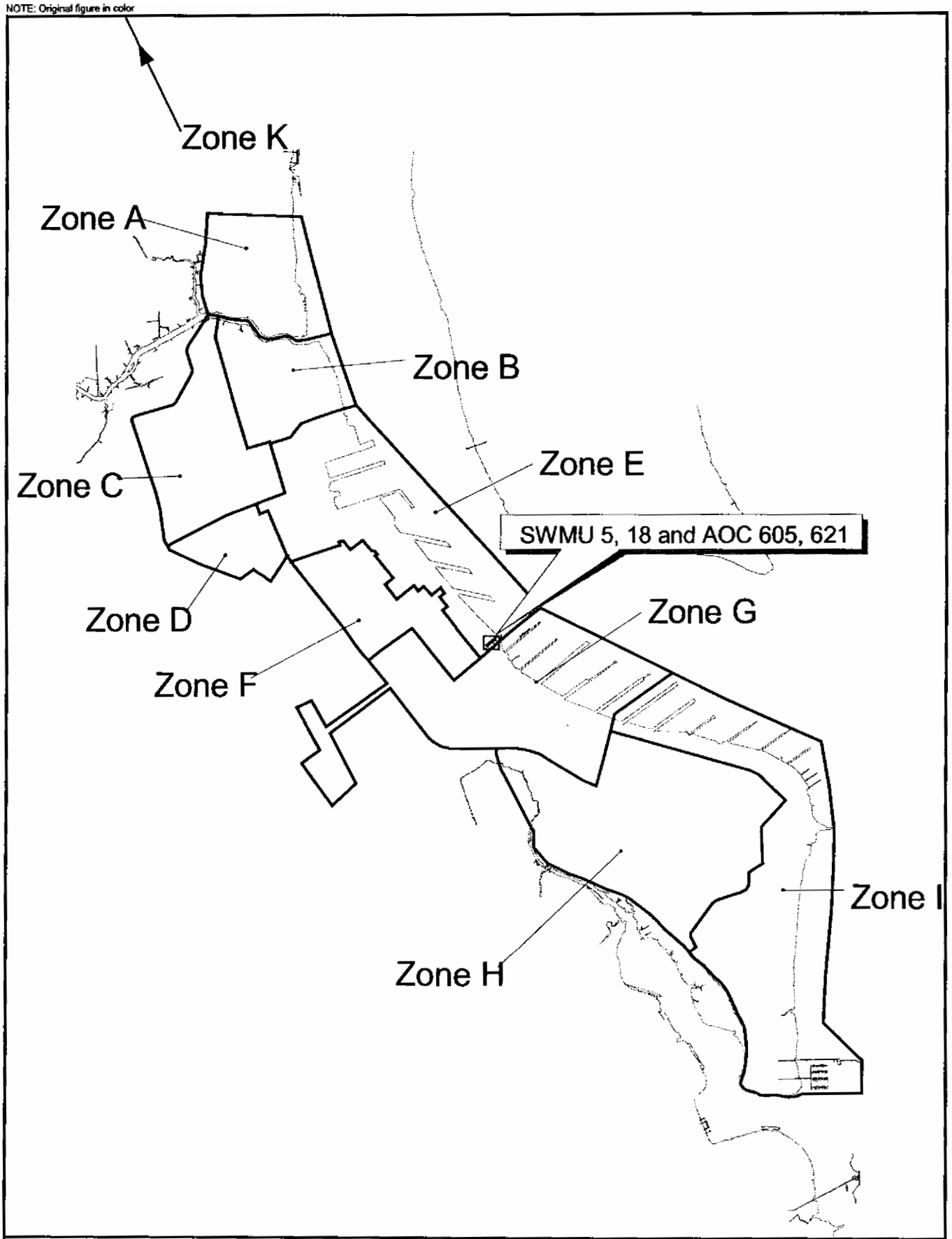
1

TABLE 1-1
Lead Concentrations in Groundwater at Combined SWMU 5
CMS Report, Combined SWMU 5, Zone E, Charleston Naval Complex

Station	Sample	Result	Unit	Qualifier	Date Collected
E018GW001	018GW00101a	4.60000	µg/L	=	03/19/1996
E018GW001	018GW00102a	2.70000	µg/L	U	07/01/1996
E018GW001	018GW00103a	1.70000	µg/L	U	10/28/1996
E018GW001	018GW00104a	1.70000	µg/L	U	01/07/1997
E018GW001	018GW001L2	5.58000	µg/L	=	12/05/2001
E018GW002	018GW00201a	3.00000	µg/L	U	03/20/1996
E018GW002	018GW00202a	1.40000	µg/L	U	07/01/1996
E018GW002	018GW00203b	1.70000	µg/L	U	10/28/1996
E018GW002	018GW00204a	1.70000	µg/L	U	01/07/1997
E018GW002	018GW002L2	2.43000	µg/L	U	12/05/2001
E605GW001	605GW00101	3.00000	µg/L	U	03/19/1996
E605GW001	605GW00102	3.80000	µg/L	U	07/01/1996
E605GW001	605GW00103	1.70000	µg/L	U	10/28/1996
E605GW001	605GW00104	1.70000	µg/L	U	01/07/1997
E605GW002	605GW00201	**426.00000**	µg/L	=	03/20/1996
E605GW002	605GW00202	**68.60000**	µg/L	=	07/02/1996
E605GW002	605GW00203	**404.00000**	µg/L	=	10/28/1996
E605GW002	605GW00204	**1970.00000**	µg/L	=	01/07/1997
E605GW003	605GW00301	3.00000	µg/L	U	03/20/1996
E605GW003	605GW00302	2.50000	µg/L	U	07/02/1996
E605GW003	605GW00303	1.70000	µg/L	U	10/28/1996
E605GW003	605GW00304	1.70000	µg/L	U	01/08/1997
E605GW004	605GW004L2	**21.40000**	µg/L	=	12/05/2001
E605GW004	605GW004M1	15.00000	µg/L	=	09/05/2002
E605GW005	605GW005L2	4.63000	µg/L	=	12/05/2001
E605GW005	605GW005M1	7.00000	µg/L	=	09/05/2002
E605GW006	605GW006L2	3.77000	µg/L	=	12/05/2001
E605GW04R	605GW04RN1	3.70000	µg/L	=	02/28/2003
E605GW05R	605GW05RN1	2.67000	µg/L	U	02/28/2003
E605GW06R	605GW06RN1	2.88000	µg/L	J	02/28/2003

Note: Bold values exceed the Target Treatment Level (TTL) for lead of 15 ug/L.

NOTE: Original figure in color



Shoreline
Zone Boundary

N

0 3000 6000 Feet

1 inch = 2666.67 feet

Figure 1-1
Site Location Map
SWMU 5, SWMU 18, AOC 605, and AOC 621
Zone E
Charleston Naval Complex

CH2MHILL

File Path: e:\projects\charleston\figures\aprs\zonee\sitelocationszonee.apr, Date: 11 Jun 2001 6:58, User: NMOUDRY

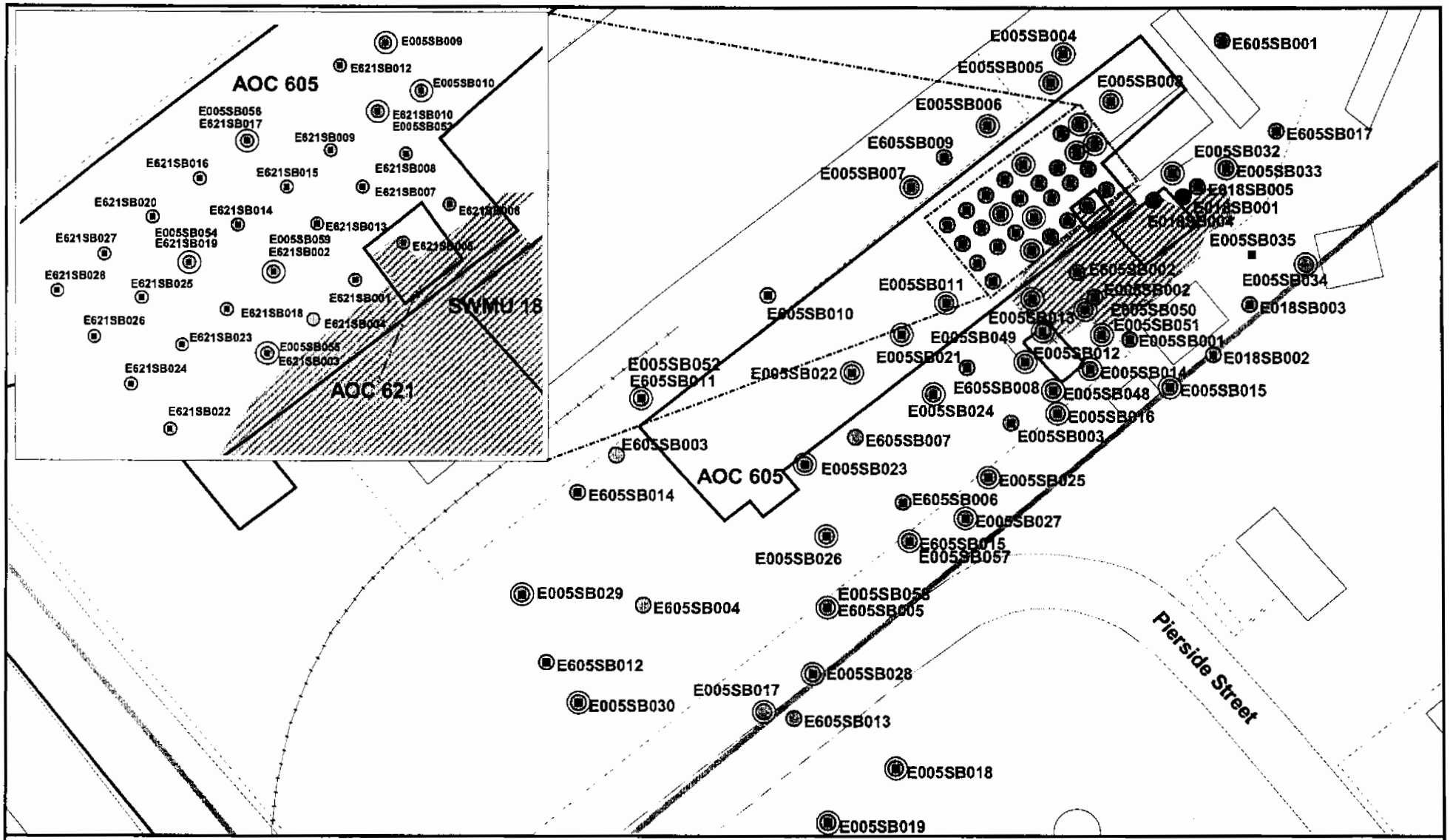
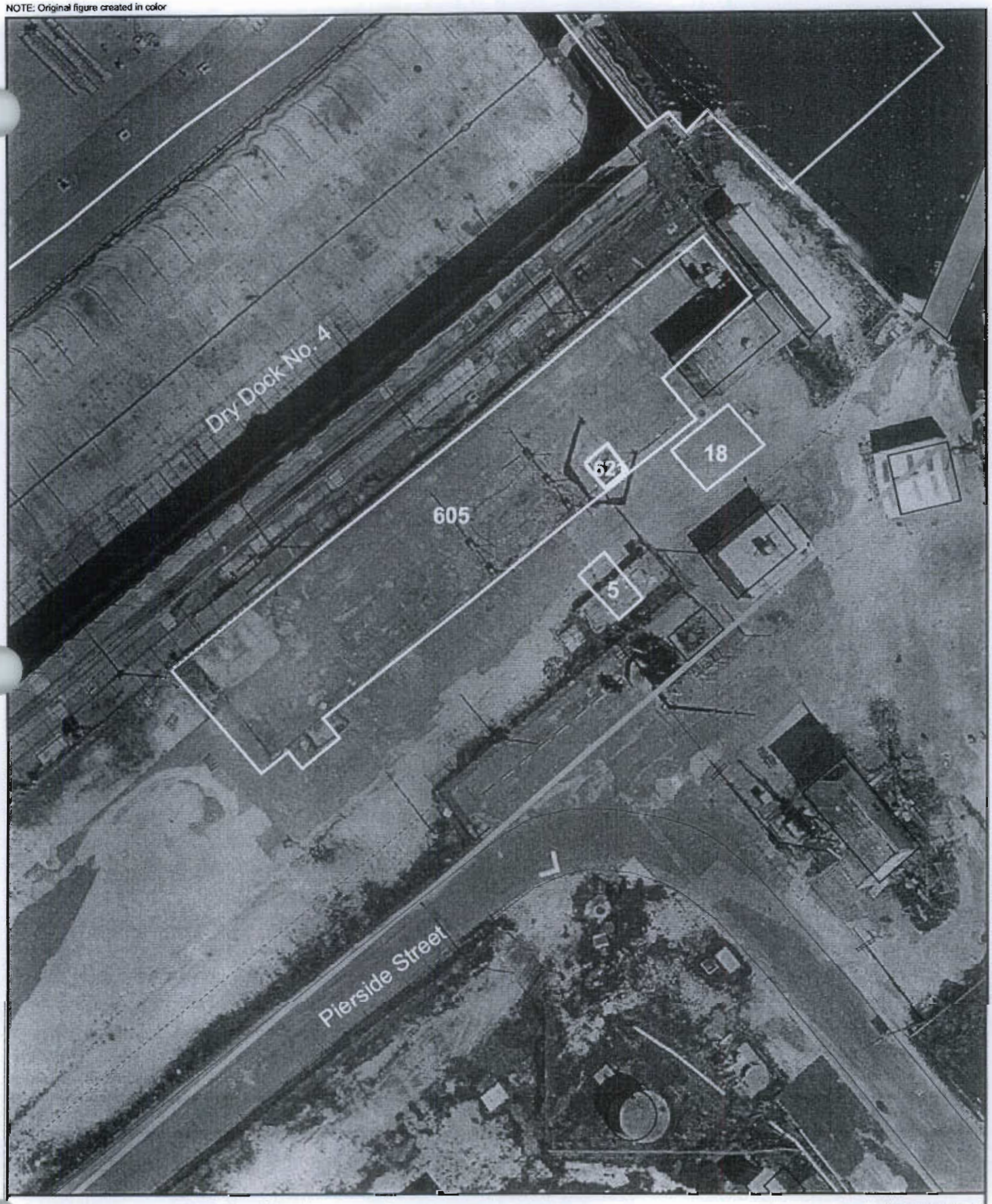


Figure 1-3
RFI Soil Sample Locations
Combined SWMU 5, Zone E
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_E\aoc605_swmu5&18\Aprs\aoc_605_031203.apr, Date: 01 Apr 2003 13:03, User: ASPOSATO, Figure 4-1 Soil Sample Locations

NOTE: Original figure created in color



Fence
Railroads
Roads
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 40 80 Feet

1 inch = 50 feet

Figure 1-2
Site Map
SWMU 5, SWMU 18, AOC 605, and AOC 621
Zone E
Charleston Naval Complex

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File Path: C:\1Bgis\Projects\Zone E\SWMU5_SWMU18_AOC605\swmu5aoc605swmu18.apr, Date: 26 Jun 2001 9:00, User: NMOUDRY

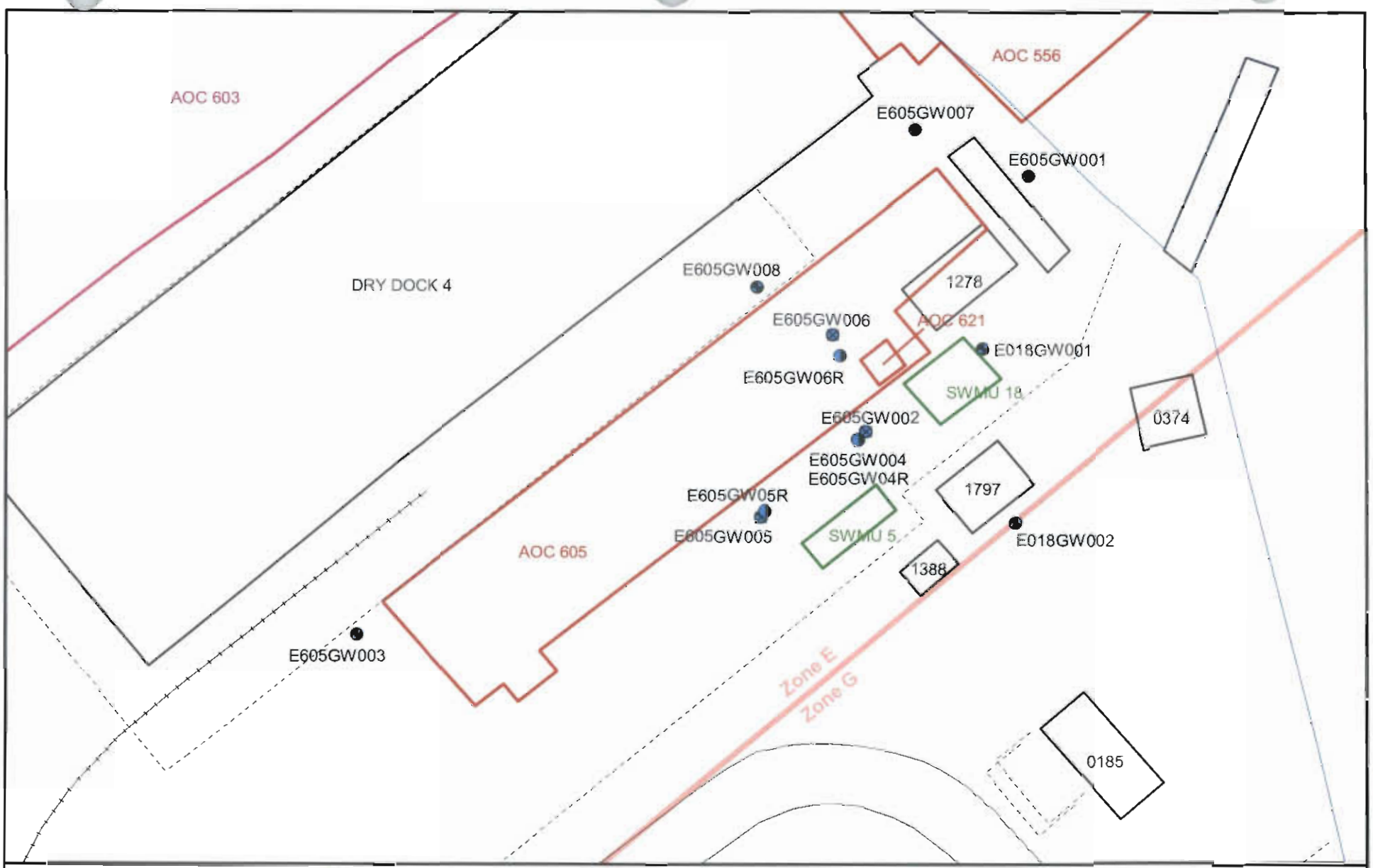
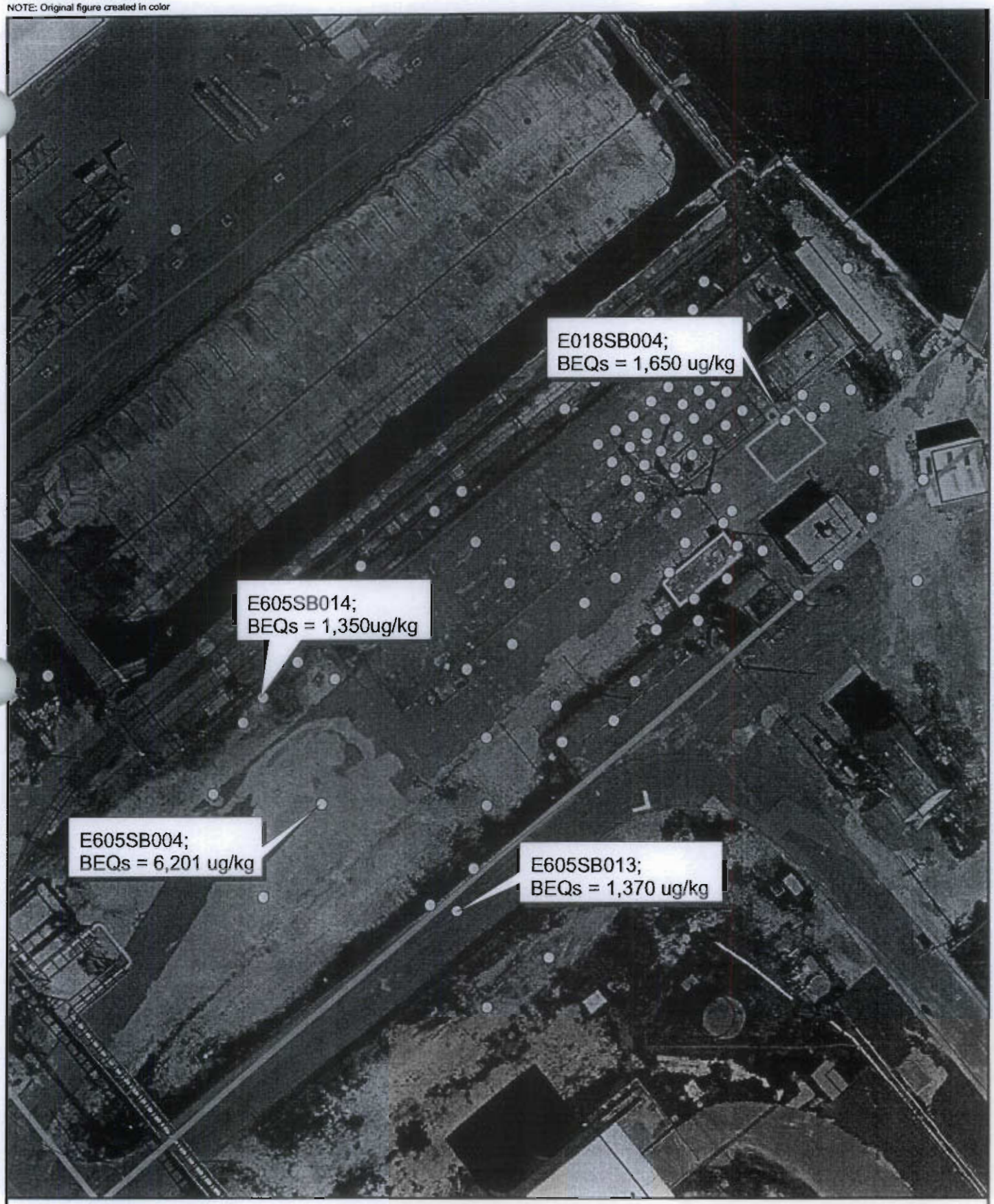


Figure 1-4
Groundwater Well Locations
Combined SWMU 5, Zone E
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_E\aoc605_swmu5&18\Aprs\swmu5_031803.apr, Date: 01 Apr 2003 11:54, User: ASPOSATO, Figure 4-2 Groundwater Well Locations

NOTE: Aerial Photo Date is 1997
NOTE: Original figure created in color



○ Surface Soil

N

0 50 100 Feet

1 inch = 58.6848 feet

Figure 1-5
BEQ Exceedances in Surface Soil
Combined SWMU 5, Zone E
Charleston Naval Complex

File Path: c:\18gis\cnc\cnc-egis.apr, Date: 01 Dec 2003 16:49, User: DWILLIAM, EGIS: Charleston Naval Complex - Figure 1-5 BEQ Exceedances in Surface Soil

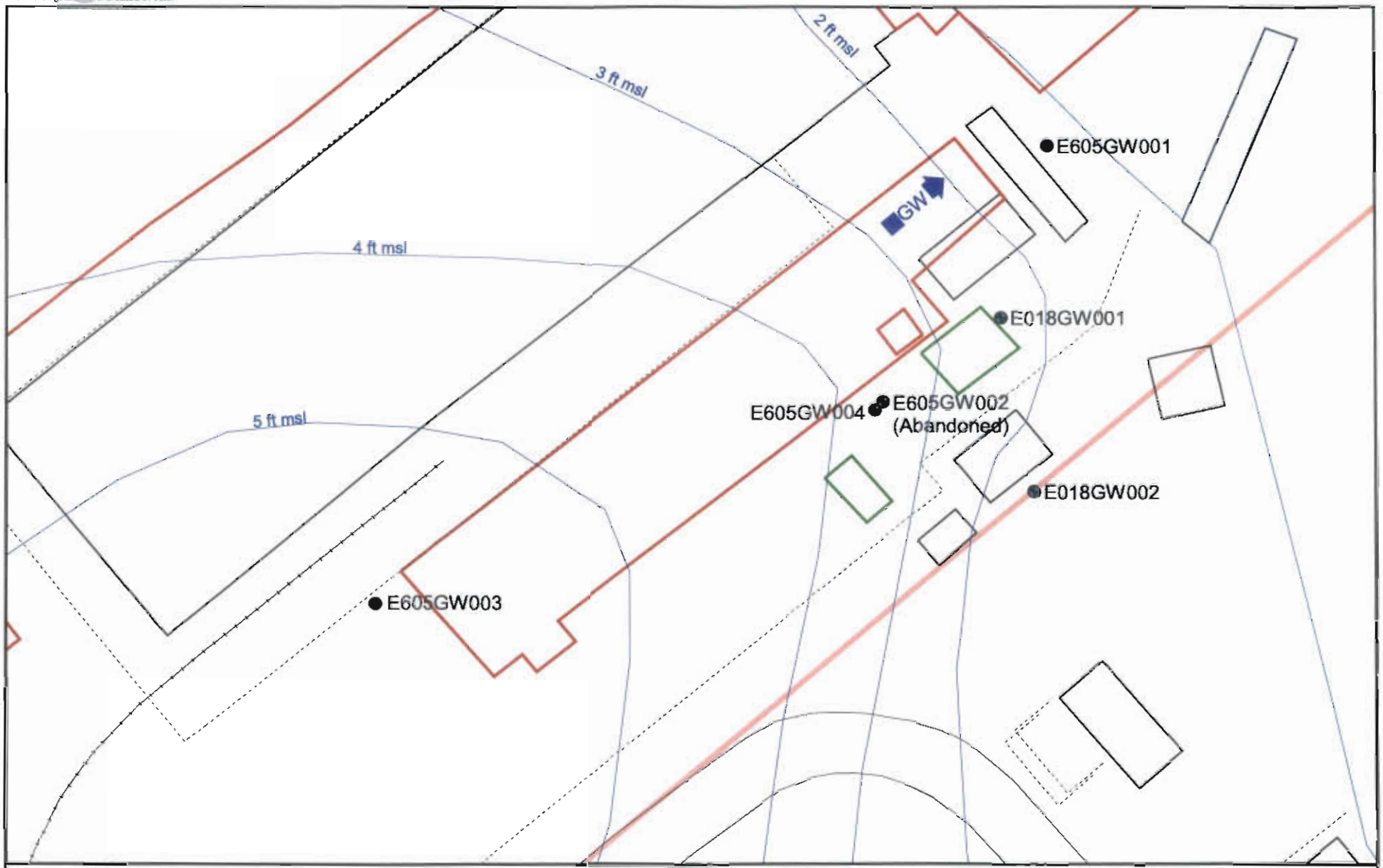
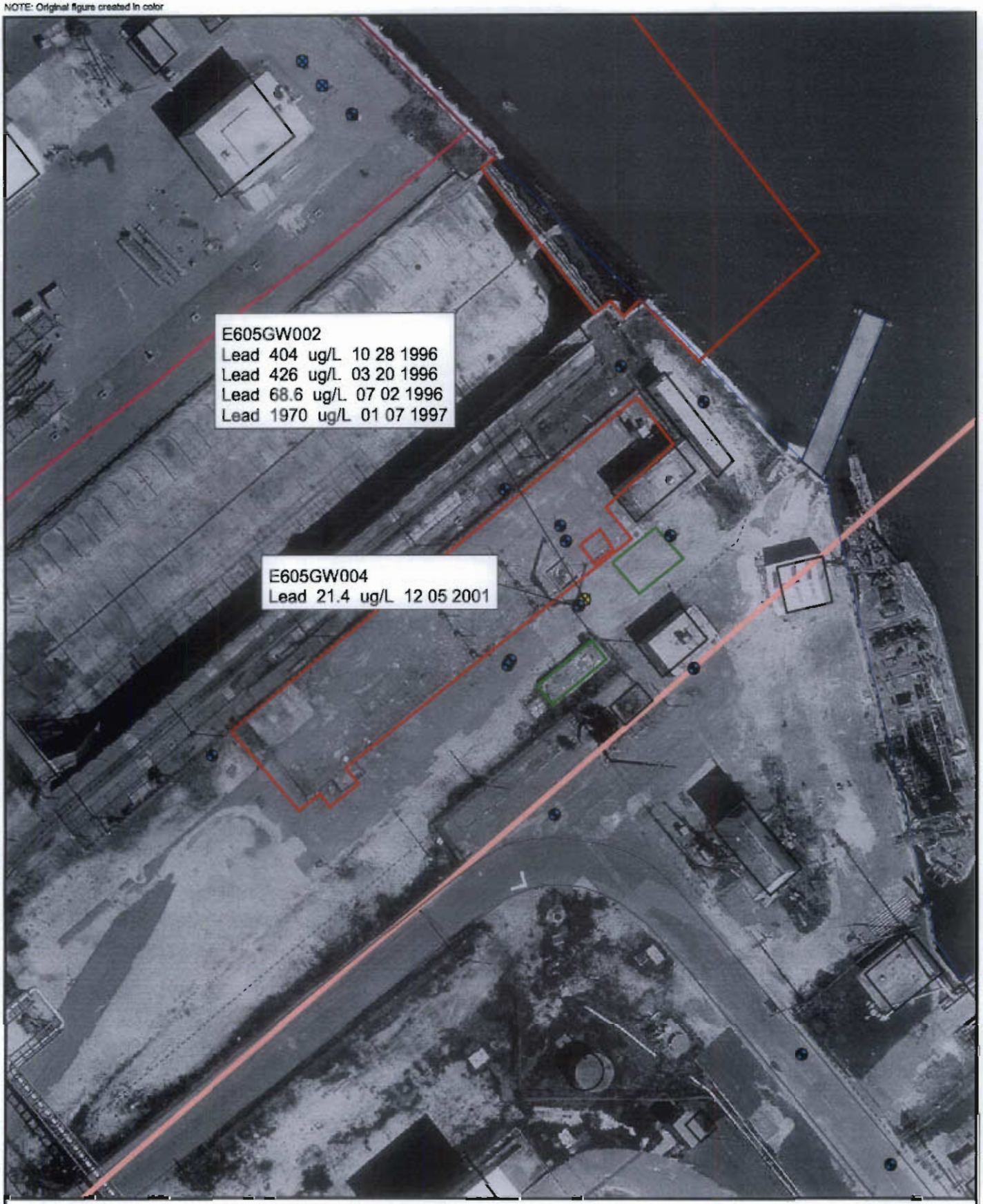


Figure 1-6
Shallow Groundwater Contours
Combined SWMU 5, Zone E
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_E\aoc605_swmu5&18\Aprs\5_18_605je2a.apr, Date: 08 Jul 2003 9:24, User: JEDENS, EGIS: Charleston Naval Complex - Figure 4-3 Shallow Groundwater Contours

NOTE: Aerial Photo Date is 1997
NOTE: Original figure created in color



Abandoned
Active

N

0 50 100 Feet

1 inch = 65.1976 feet

Figure 1-7
Lead Exceedances in Groundwater
Combined SWMU 5, Zone E
Charleston Naval Complex

File Path: c:\18gis\cnc\cnc-egis.apr, Date: 02 Dec 2003 10:38, User: DWILLIAM, EGIS: Charleston Naval Complex - Figure 1-7 Lead Exceedances in Groundwater

Section 2.0

2.0 Remedial Goal Objectives and Evaluation Criteria

2.1 Remedial Action Objectives

RAOs are medium-specific goals that protect human health and the environment by preventing or reducing exposures under current and future land use conditions. The RAO identified for the subsurface soil at Combined SWMU 5 is to achieve concentrations of COCs that are protective of groundwater (prevent leaching of COCs at concentrations that cause concentrations of COCs in groundwater to exceed their target MCS. The RAO for groundwater is to prevent ingestion of groundwater containing COCs at unacceptable levels and to restore the aquifer to its beneficial use to the extent practicable.

2.2 Media Cleanup Standards

Throughout the process of remediating a hazardous waste site, a risk manager uses a progression of increasingly acceptable site-specific media levels in considering remedial alternatives. Under the RCRA program, RGOs and MCSs are developed at the end of the risk assessment in the RFI/Remedial Investigation (RI) programs, before completion of the CMS.

RGOs can be based on a variety of criteria, such as specific incremental lifetime cancer risk (ILCR) levels (e.g., 1E-04, 1E-05, or 1E-06), hazard index (HI) levels (e.g., 0.1, 1.0, 3.0), or site background concentrations. For a particular RGO, specific MCSs can be determined as target concentration values. Achieving these MCSs is accepted as demonstrating that RGOs and RAOs have been achieved. Achieving these goals should promote the protection of human health and the environment, while achieving compliance with applicable state and federal standards.

The exposure media of concern for Combined SWMU 5 are subsurface soil containing PAHs (BEQs), antimony, and lead, and groundwater containing antimony, lead, nickel, and thallium.

For the chemicals identified as COCs in soil and shallow groundwater, the following MCSs were previously proposed in the CMS Work Plan:

COC	Target MCS as Proposed in CMS Work Plan
Surface Soil	
PAHs (BEQs)	CNC Sitewide Reference Concentration for Subsurface Soils - 1,304 µg/kg
Groundwater	
Lead	Drinking water Target Treatment Level for lead - 15 µg/L

2.3 Evaluation Criteria

According to the EPA RCRA CA guidance, corrective measure alternatives should be evaluated using the following five criteria:

1. Protection of human health and the environment.
2. Attainment of MCSs.
3. The control of the source of releases to minimize future releases that may pose a threat to human health and the environment.
4. Compliance with applicable standards for the management of wastes generated by remedial activities.
5. Other factors, including (a) long-term reliability and effectiveness; (b) reduction in toxicity, mobility, or volume of wastes; (c) short-term effectiveness; (d) implementability; and (e) cost.

Each of these criteria is defined in more detail below:

1. **Protection of human health and the environment.** The alternatives will be evaluated on the basis of their ability to protect human health and the environment. The ability of an alternative to achieve this criterion may or may not be independent of its ability to achieve the other criteria. For example, an alternative may be protective of human health, but may not be able to attain the MCSs if the MCSs were not developed based on human health protection factors.

2. **Attainment of MCSs.** The alternatives will be evaluated on the basis of their ability to achieve the MCS defined in this CMS. Another aspect of this criterion is the time frame required to achieve the MCS. Estimates of the time frame for the alternatives to achieve RGOs will be provided.

3. **The control the source of releases.** This criterion deals with the control of releases of contamination from the source (the area in which the contamination originated) and the prevention of future migration to uncontaminated areas.

4. **Compliance with applicable standards for management of wastes.** This criterion deals with the management of wastes derived from implementing the alternatives (i.e., treatment or disposal of contaminated residuals from groundwater treatment processes). Corrective measure alternatives will be designed to comply with all standards for management of wastes. Consequently, this criterion will not be explicitly included in the detailed evaluation presented in the CMS, but such compliance would be incorporated into the cost estimates for which this criterion is relevant.

5. **Other factors.** Five other factors are to be considered if an alternative is found to meet the four criteria described above. These other factors are as follows:

   a. Long-term reliability and effectiveness

   Corrective measure alternatives will be evaluated on the basis of their reliability, and the potential impact should the alternative fail. In other words, a qualitative assessment will be made as to the chance of the alternative's failing and the consequences of that failure.

   b. Reduction in the toxicity, mobility, or volume of wastes

   Alternatives with technologies that reduce the toxicity, mobility, or volume of the contamination will be generally favored over those that do not. Consequently, a qualitative assessment of this factor will be performed for each alternative.

   c. Short-term effectiveness

   Alternatives will be evaluated on the basis of the risk they create during the implementation of the remedy. Factors that may be considered include fire, explosion, and exposure of workers to hazardous substances.

   d. Implementability

   The alternatives will be evaluated for their implementability by considering any difficulties associated with conducting the alternatives (such as the construction disturbances they may create), operation of the alternatives, and the availability of equipment and resources to implement the technologies comprising the alternatives.

   e. Cost

A net present value of each alternative will be developed. These cost estimates will be used for the relative evaluation of the alternatives, not to bid or budget the work. The estimates will be based on information available at the time of the CMS and on a conceptual design of the alternative. They will be "order-of-magnitude" estimates with a generally expected accuracy of -50 percent to +100 percent for the scope of action described for each alternative. The estimates will be categorized into capital costs and operations and maintenance costs for each alternative.

Section 3.0

3.0 Description of Candidate Corrective Measure Alternatives

3.1 Introduction

Currently available soil and groundwater remedial technologies were screened for applicability to the contaminants and physical conditions present at Combined SWMU 5, with only the most viable technologies known for addressing the COCs present at the site selected for alternatives analysis.

Two remedies will be considered for the COCs in the CMS for Combined SWMU 5:

- Soil Excavation, Groundwater Monitoring, and LUCs, and
- Groundwater Monitoring and LUCs.

The sections below describe each alternative in more detail.

3.2 Alternative 1: Soil Excavation, Groundwater Monitoring, and LUCs

3.2.1 Description of Alternative

This alternative would involve excavation of surface soil containing BEQ concentrations greater than the CNC sitewide reference concentration for surface soil of 1,304 µg/kg. Excavated soil would be transported to a permitted landfill facility for long-term disposal, and the excavation would be filled with clean fill from an offsite borrow source.

Because lead in surface soil exceeds the target cleanup level for unrestricted land use (400 milligrams per kilogram [mg/kg]), LUCs will be implemented to restrict site use to industrial land use only. Also, because the site is located in Zone E, there will continue to be LUCs that apply to the entire zone. These LUCs are expected to include restrictions of the property to non-residential activities.

Groundwater monitoring for lead would also be conducted to confirm that lead concentrations in groundwater continue not to exceed the MCS of 15 µg/L.

3.2.2 Key Uncertainties

No significant uncertainties exist for this alternative.

3.2.3 Other Considerations

Coordination with the CNC Redevelopment Authority (RDA) and the utility companies would be required for site restrictions during excavation, and traffic control is needed for the haul trucks. The potential for expansion of scope during confirmation testing is moderate.

3.3 Alternative 2: Groundwater Monitoring and LUCs

3.3.1 Description of Alternative

This alternative involves leaving the BEQ-impacted soil (and co-located overlying pavement) in place and instituting administrative/legal controls to restrict future use of the land. The controls would limit land use to activities that present less frequent exposure by sensitive populations to surface soil and preclude uncontrolled disturbance of the contaminated soil, thus minimizing the potential for human exposure to the contamination. The addition of restrictions on soil disturbance and site occupancy would minimize potential for human exposure that could occur in a residential or industrial setting. The controls may be in the form of deed restrictions and/or easements (property interests retained by the Navy during property transfer to assure protectiveness of the remedy). Periodic monitoring would be required to assure controls are maintained; periodic site inspections would be required to assure compliance with the institutional controls. Controls may be layered (multiple controls at the same time) to enhance protectiveness. The Navy is negotiating a comprehensive Land Use Control Implementation Plan (LUCIP) for the CNC.

The locations where the BEQs in surface soil exceed the CNC sitewide reference concentration are all paved. Thus no exposure to receptors of BEQs above the sitewide reference concentration is occurring or expected to occur at the site. This alternative is therefore considered adequately protective of human health and the environment.

Groundwater monitoring for lead would also be conducted to confirm that lead concentrations in groundwater continue not to exceed the MCS of 15 $\mu g/L$.

3.3.2 Key Uncertainties

No significant uncertainties were noted regarding this alternative.

3.3.3 Other Considerations

Currently, the Navy is the property owner and land use in Zone E in the CNC is restricted to non-residential. Existing engineering controls include pavement and structures that

prevent or limit access to contaminated soil. The location and proximity of the site to other industrial properties make residential use highly unlikely, and the substantial dock structures hinder access to the soil by commercial/industrial users. Periodic monitoring of the deed controls and the site would be required. For the purpose of developing a representative cost estimate for this process, an annual evaluation that would include a site inspection is assumed.

Section 4.0

4.0 Evaluation and Comparison of Corrective Measure Alternatives

The two corrective measure alternatives were evaluated relative to the evaluative criteria described in Section 2.0 and then subjected to a comparative evaluation. A cost estimate for each alternative was also developed; the assumptions and unit costs used for these estimates are included in Appendix A.

4.1 Alternative 1: Soil Excavation, Groundwater Monitoring, and LUCs

The assumptions for Alternative 1 include the following:

- A base-wide land use control management plan (LUCMP) will be developed for the CNC. The plan will allow for restrictions on the use of groundwater at Combined SWMU 5 and other areas and will be developed outside the scope of this CMS.
- For cost estimating purposes, it is assumed that an area of surface soil 150-foot by 80-foot by 1-foot deep would be excavated to remove the area where BEQs exceed the CNC sitewide reference concentration.
- The excavated soil would be disposed as non-hazardous waste.
- Groundwater monitoring for lead will be performed for up to 1 year, at which point it will be confirmed that lead concentrations in groundwater continue to be below the MCS and that lead does not represent an unacceptable risk to human health or the environment. Samples will be collected from the existing monitoring well that has had past MCS exceedances, on a semi-annual basis. The samples will be analyzed for lead, filtered and unfiltered. Standard field parameters (dissolved oxygen [DO], oxidation reduction potential [ORP], turbidity, temperature) will also be monitored.

4.1.1 Protection of Human Health and the Environment

Alternative 1 is effective at protecting human health and the environment because it removes soil with BEQ concentrations that exceed the MCS from the site. The replacement soil will have concentrations of BEQs below the MCS.

4.1.2 Attain MCS

Alternative 1 will permanently remove soil with BEQ concentrations that exceed the MCS. The MCS will be achieved at the completion of soil removal actions.

4.1.3 Control the Source of Releases

There are no ongoing sources of releases at Combined SWMU 5; therefore, this issue is not applicable.

4.1.4 Compliance with Applicable Standards for the Management of Generated Wastes

Alternative 1 can be implemented in compliance with current standards. Soil excavation uses conventional technology and has been implemented effectively and safely many times at the CNC. The primary generated waste would be excavated soil, which is easily managed to applicable standards. Excavated soil will be sampled and analyzed for waste characterization prior to disposal. Soil, decontamination waste, and personal protective equipment (PPE) will be disposed in accordance with applicable regulations and permits. Offsite transportation and disposal will be performed by properly permitted and licensed subcontractors.

4.1.5 Other Factors (a) Long-term Reliability and Effectiveness

Alternative 1 has adequate long-term reliability and effectiveness.

4.1.6 Other Factors (b) Reduction in the Toxicity, Mobility, or Volume of Wastes

Alternative 1 reduces the mobility of the contaminated soil by transporting it to a regulated containment facility (landfill). Treatment will not be required unless the soil exhibits toxicity characteristics per 40 CFR 261.24. If required, soil will be treated (stabilized/fixated) at the disposal facility to further reduce mobility of the BEQs.

4.1.7 Other Factors (c) Short-term Effectiveness

The excavation and hauling of contaminated soil in this alternative has the potential to create dust containing contaminated soil particles. However, standard engineering controls such as dust suppression during excavation, tarp covers on trucks, and worker PPE to prevent dust inhalation will be implemented. Thus, with controls, the alternative provides short-term effectiveness in preventing ingestion of or contact with the contaminated soil and minimizes the potential for migration of soil particles. The technologies for dust control and worker protection are well-established and robust. No unmanageable hazards would be created during implementation.

4.1.8 Other Factors (d) Implementability

This alternative will be moderately difficult to implement. Most of the required activities have been implemented at other sites using standard equipment and procedures. Unknown buried utilities and structures could be encountered. Utility clearance, subcontracting, waste characterization, and base approval are other customary activities. The field implementation of this remedy is estimated to require 6 to 8 weeks, and the benefits will be immediate. There is ample offsite capacity for disposal (and treatment, if required) of the contaminated soil.

4.1.9 Other Factors (e) Cost

Alternative 1 is the more costly to implement since it provides for soil excavation and offsite disposal. Using the assumptions described earlier, the total present value of this alternative is $313,000.

4.2 Alternative 2: Groundwater Monitoring and LUCs

The assumptions for Alternative 2 include the following:

- A base-wide LUCMP will be developed for the CNC. The plan will allow for restrictions on the use of Combined SWMU 5 for industrial applications only and will be developed outside the scope of this CMS.

- Groundwater monitoring for lead will be performed for up to 1 year, at which point it will be confirmed that lead concentrations in groundwater continue to be below the MCS and that lead does not represent an unacceptable risk to human health or the environment. Samples will be collected from the existing monitoring well that has had past MCS exceedances, on a semi-annual basis. The samples will be analyzed for lead, filtered and unfiltered. Standard field parameters (DO, ORP, turbidity, temperature) will also be monitored.

4.2.1 Protection of Human Health and the Environment

Alternative 2 is effective at protecting human health and the environment because it uses LUCs to ensure that the site remains paved and used for industrial use only to prevent exposure of receptors to contaminated soil.

4.2.2 Attain MCS

Alternative 2 will not achieve the MCS for BEQs.

4.2.3 Control the Source of Releases

There are no ongoing sources of releases at Combined SWMU 5; therefore, this issue is not applicable.

4.2.4 Compliance with Applicable Standards for the Management of Generated Wastes

Alternative 2 does not generate any wastes that require special management.

4.2.5 Other Factors (a) Long-term Reliability and Effectiveness

This alternative provides some level of protection that has long-term reliability and effectiveness. The risk of failure is low, provided the LUCMP is enforced by the responsible entity. If LUCs were not enforced, unpermitted use of the site may result in human exposure to BEQs above the MCS.

4.2.6 Other Factors (b) Reduction in the Toxicity, Mobility, or Volume of Wastes

Alternative 2 involves no treatment and thus does not reduce the toxicity, mobility, and volume of the BEQ-impacted soil.

4.2.7 Other Factors (c) Short-term Effectiveness

Because of the implementation of LUCs, this alternative will have short-term effectiveness in preventing exposure of receptors to contaminated soil. No unmanageable hazards would be created during its implementation.

4.2.8 Other Factors (d) Implementability

Alternative 2 is relatively easy to implement since it requires only the development of LUCs and an appropriate monitoring program.

4.2.9 Other Factors (e) Cost

Alternative 2 is not costly to implement since it requires no construction of treatment facilities or disposal of wastes. The cost for this alternative is for administrative/legal services and periodic monitoring/review for 30 years. Longer monitoring would likely be required, but its cost impact to present value of this alternative is minimal.

Using the assumptions described earlier, the total present value of Alternative 2 is $23,000. Appendix A presents the overall cost estimate for implementing this remedy.

4.3 Comparative Evaluation of Corrective Measure Alternatives

Each corrective measure alternative's overall ability to meet the evaluation criteria is described above. Table 4-1 presents a comparative evaluation of the degree to which each alternative meets particular criteria.

TABLE 4-1
Comparative Evaluation of Corrective Measure Alternatives
CMS Report, Combined SWMU 5, Zone E, Charleston Naval Complex

Criterion	Alternative 1 Soil Excavation, Groundwater Monitoring, and LUCs	Alternative 2 Groundwater Monitoring and LUCs
Overall Protection of Human Health and the Environment	Adequately protects human health and the environment	Adequately protects human health and the environment
Attainment of MCS	Expected to attain MCSs within 1 years	Will not attain the BEQ MCS for surface soil
Control of the Source of Releases	No sources present at this site	No sources present at this site
Compliance with Applicable Standards for the Management of Wastes	Can be implemented to comply with applicable standards	Can be implemented to comply with applicable standards
Long-term Reliability and Effectiveness	Expected to be reliable and effective in the long-term	Expected to be reliable and effective in the long-term
Reduction of Toxicity, Mobility, or Volume through Treatment	Reduces toxicity, mobility, and volume via natural attenuation and soil excavation	Does not reduce toxicity, mobility, and volume via natural attenuation
Short-term Effectiveness	Effective in short term via LUCs	Effective in short term via LUCs
Implementability	Moderately easily implemented	Very easily implemented
Estimated Cost (in $1,000)	$313,000	$23,000

Section 5.0

5.0 Recommended Corrective Measure Alternative

Two corrective measure alternatives were evaluated for addressing BEQ-impacted surface soil and for monitoring lead in groundwater using the criteria described in Section 2.0 of this CMS report: Alternative 1: Soil Excavation, Groundwater Monitoring, and LUCs; and Alternative 2: Groundwater Monitoring and LUCs.

Based on the alternatives evaluation and RAOs for the site, as identified in Section 2.0, and the current uncertainties associated with each alternative, the preferred corrective measure alternative is Alternative 2: Groundwater Monitoring and LUCs. Alternative 2 would provide protection of human health and the environment through the implementation of LUCs at the site. This alternative also provides for maintaining the current and planned future use of the site as industrial as long as site COCs exceed applicable levels for unrestricted land use. LUCs would prevent residential and other unrestricted land uses.

An LUCMP is being developed for the industrial areas of the CNC, and Combined SWMU 5 will be added to the plan. The LUCMP will limit future site activities to those that would limit exposure to groundwater. The expected reliability of this alternative is good. Should monitoring data indicate that this alternative is not as effective as expected, additional measures could be safely implemented.

Section 6.0

6.0 References

CH2M-Jones. RFI Report Addendum and CMS Work Plan, Combined SWMU 5, Zone E, Charleston Naval Complex. Revision 0. May 2003.

EnSafe Inc. *Zone E RFI Report, NAVBASE Charleston, Revision 0.* November 1997.

EnSafe Inc./Allen & Hoshall. *Zone E RFI Report Workplan.* 1995.

South Carolina Department of Health and Environmental Control (SCDHEC). RCRA Permit SC0 170 022 560. Charleston Naval Complex, Charleston, South Carolina. August 17, 1988.

U.S. Environmental Protection Agency (EPA). Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Office of Solid Waste and Emergency Response (OSWER) Final Directive 9200.4-17P. 1999.

Appendix A

COMPARISON OF TOTAL COST OF REMEDIAL SOLUTIONS

Site:	Charleston Naval Complex	**Base Year:**	2003
Location:	Combined SWMU 5	**Date:**	12/02/2003
Phase:	Corrective Measures Study		

	Alternative Number 1	Alternative Number 2
Total Project Duration (Years)	<1	30
Capital Cost	$290,000	$20,000
Annual O&M Cost	$0	$3,500
Total Present Value of Solution	$313,000	$23,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: Number 1 — **COST ESTIMATE SUMMARY**

Elements: Soil Excavation and Offsite Disposal

Site: Charleston Naval Complex

Location: Combined SWMU 5

Phase: Corrective Measures Study

Base Year: 2003

Date: 12/02/2003

Description: Excavation of contaminated soil, disposal offsite at permitted landfill, backfill with clean soil. Extent includes RFI sample points plus 30% scope contingency.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Confirmation Sampling	1	EA	$9,000	$9,000	See Confirmation Worksheet
Removal, Disposal and Backfill	1	EA	$192,000	$192,000	See Excavation 1 Worksheet
				$0	
SUBTOTAL				$201,000	
Contingency	30%		$201,000	$60,300	
SUBTOTAL				**$261,300**	
Project Management	5%		$261,300	$13,065	USEPA 2000, p. 5-13, $100K-$500K
Remedial Design	3%		$261,300	$7,839	
Construction Management	3%		$261,300	$7,839	USEPA 2000, p. 5-13, $100K-$500K
SUBTOTAL				**$28,743**	
TOTAL CAPITAL COST				**$290,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL ANNUAL O&M COST				**$0**	

PRESENT VALUE ANALYSIS

Discount Rate = 7%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
0	CAPITAL COST	$290,000	$290,000	1.000	$290,000	
	ANNUAL O&M COST	$0	$0	0.000	$0	
		$290,000			$290,000	
	PRESENT VALUE OF LUC and GW Sampling (1 year)				$23,000	
	TOTAL PRESENT VALUE OF ALTERNATIVE				**$313,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: Number 2 — **COST ESTIMATE SUMMARY**
Elements: Land Use Controls

Site: Charleston Naval Complex
Location: Combined SWMU 5
Phase: Corrective Measures Study
Base Year: 2003
Date: 12/02/2003

Description: Implementation of base-wide land use management plan to put instituional controls in place to restrict site use to commercial/industrial.

Assumes this site is part of a multi-site implementation, and costs are shared among all the sites.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
LUC Implementation	1	each	$20,000	$20,000	
SUBTOTAL				$20,000	
Contingency	0%		$20,000	$0	
SUBTOTAL				**$20,000**	
Project Management	0%		$20,000	$0	USEPA 2000, p. 5-13, <$100K
Remedial Design	0%		$20,000	$0	Not applicable.
Construction Management	0%		$20,000	$0	Not applicable.
SUBTOTAL				**$0**	
TOTAL CAPITAL COST				**$20,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Lead Sampling	1	each	$2,000	$2,000	
Annual Evaluation	12	hour	$75	$900	
SUBTOTAL				$2,900	
Allowance for Misc. Items	20%		$2,900	$580	
SUBTOTAL				$3,480	
TOTAL ANNUAL O&M COST				**$3,500**	

PRESENT VALUE ANALYSIS - 20 years

Discount Rate = 7%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
0	CAPITAL COST	$20,000	$20,000	1.000	$20,000	
1	ANNUAL O&M COST	$3,500	$3,500	0.935	$3,271	
		$23,500			$23,271	
	TOTAL PRESENT VALUE OF ALTERNATIVE				**$23,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Subtask** **COST WORKSHEET 1**

Element: **Confirmation Testing**

Site: Charleston Naval Complex
Location: Combined SWMU 5
Phase: Corrective Measures Study
Base Year: 2003

Prepared By: DFW **Date:** 12/02/2003
Checked By: **Date:**

WORK STATEMENT

Costs for soil confirmation sample collection, shipment and analysis on a per event basis.
Total of 40 samples: 1 sidewall sample every 50 ft along a total perimeter of approximately 1200 LF = 24
1 floor sample per 50 ft x 50 ft excavated area= 10 samples
Add 6 QA/QC samples

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor					
Jar Kits	40	EA	$10	$400	CH2M-Jones Est.
Coolers	6	EA	$10	$60	CH2M-Jones Est.
Disposable Gloves	5	BOXES	$20	$100	CH2M-Jones Est.
Collection of samples	30	HR	$68	$2,040	CH2M-Jones Est.
Sample Shipment	6	EA	$20	$120	CH2M-Jones Est.
Sample Analysis (SVOCs)	40	SAMPLE	$95	$3,800	GEL, PEL, STL average
Data Validation	10	HR	$100	$1,000	CH2M-Jones Est.
SUBTOTAL				$7,520	
Allowance for Misc. Items	20%		$7,520	$1,504.00	
SUBTOTAL				$9,024	
TOTAL COST				**$9,000**	

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL O&M COST				**$0**	

Source of Cost Data

1. Analytical Bid Form - Charleston Naval Complex - Level II

Alternative: **Subtask** **COST WORKSHEET 2**

Element: **Soil Excavation and Disposal**

Site:	Charleston Naval Complex	**Prepared By:** SN		**Checked By:** DFW	
Location:	Combined SWMU 5	**Date:**	12/02/2003	**Date:**	12/02/03
Phase:	Corrective Measures Study				
Base Year:	2003				

WORK STATEMENT

Excavate soil and haul to disposal area; backfill with clean soil and restore surface to original condition.
Remove and replace pavement.
See quantity calcs

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mob/demob/decon	4	EA	$1,000	$1,500	
Utility checks and permits	32	HR	$100	$3,200	CH2M-Jones Est.
Air monitoring and sampling					
Concrete cutting	350	LF	$1.15	$403	CH2M-Jones Est.
Pavement removal	12000	SF	$3.00	$36,000	CH2M-Jones Est.
Excavation (soil) - machine	2	weeks	$3,000	$6,000	CH2M-Jones Est.
Pavement disposal - Non-Haz	925	tons	$45	$41,625	CH2M-Jones Est.
Clean Fill	511	CY	$15	$7,667	CH2M-Jones Est.
Compaction machine	3	day	$50	$150	CH2M-Jones Est.
Replace asphalt	0	SF	$2	$0	CH2M-Jones Est.
Site Operator-Oversight	100	HR	$100	$10,000	CH2M-Jones Est.
Waste characterization TCLP	5	EA	$150	$750	
Contam Soil disposal - Non-Haz	665	Tons	$45	$29,925	CH2M-Jones Est.
SUBTOTAL				$137,219	
Allowance for Misc. Items	40%		$137,219	$54,888	30% Scope + 10% Bid
SUBTOTAL				$192,107	
TOTAL UNIT COST				**$192,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL ANNUAL O&M COST				**$0**	

Source of Cost Data

1. Means. 2002. Environmental Remediation Cost Data - Assemblies, 8th Edition. R.S. Means Company Kingston, MA.
2. CH2M-Jones -historic costs for CNC excavations at other sites, 2001-2002.

COST WORKSHEET 3

Removal Areas/Volumes

Combined SWMU 83 SN 12/02/2003
Alternative 1

Location	Excavation, ft L	W	D	Surface Area, sf	In Situ Pavement Thickness, ft	Pavement Volume, cy	Soil Volume, cy	
14 locations	150	80	1	12000	1	444.4	444.4	See Note 1.
Sum				12000 SF	a	444.4	444.4	CY, in situ volume (bank CY)
					b	1.3	1.2	Bulk ratio (load factor)
					c	577.8	533.1	CY, bulk volume
					d	1.6	1.3	Ton ratio
					e	925.0	665.0	Tons, bulk weight (rounded)

CHECK:

Typical in situ unit weight	150.0	110.0	PCF	
Weight of in situ volume = e/a	154.2	110.8	PCF	OK

Notes

1 Pavement (thickness assumed).