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CORRECTIVE MEASURE STUDY REPORT AREAS OF CONCERN 569, 570 AND 578 ZONE E CNC CHARLESTON SC
7/1/2004
CH2M HILL

CORRECTIVE MEASURES STUDY REPORT

AOCs 569, 570, and 578, Zone E

Charleston Naval Complex
North Charleston, South Carolina

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

CH2M Jones

July 2004

Contract N62467-99-C-0960

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: July 29, 2004

Re: Revision 1 replacement pages for *CMS Report, AOCs 569, 570, and 578, Zone E, Revision 0* – Submitted on November 13, 2003

We Are Sending You:

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

Quantity	Description
2	Revision 1 replacement pages for *CMS Report, AOCs 569, 570, and 578, Zone E, Revision 0* – Submitted on November 13, 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

THE ATTACHED PAGES SHOULD BE INSERTED AS REPLACEMENTS IN THE *CMS REPORT, AOCS 569, 570, AND 578, ZONE E, REVISION 0* SUBMITTAL:

- REVISED COVER AND SPINE
- REVISED INSIDE COVER
- REVISED CERTIFICATION PAGE
- REVISED TABLE OF CONTENTS
- REVISED SECTION 1.0 TEXT
- NEW FIGURE 1-3A
- REVISED SECTION 3.0 TEXT
- REVISED SECTION 4.0 TEXT
- REVISED TABLE 4-1
- NEW APPENDIX C RESPONSES TO SCDHEC COMMENTS ON *CMS REPORT, AOCS 569, 570, AND 578, ZONE E, REVISION 0*

CH2M HILL
115 Perimeter Center Place, NE
Suite 700
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CH2MHILL

November 13, 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) – AOCs 569, 570, and 578, Zone E

Dear Mr. Scaturo:

Enclosed please find two copies of the CMS Report (Revision 0) for AOCs 569, 570, and 578 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

AOCs 569, 570, and 578, Zone E

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO

U.S. Navy Southern Division
Naval Facilities Engineering Command

PREPARED BY

CH2M-Jones

July 2004

Revision 1
Contract N62467-99-C-0960
158814.ZE.EX.09

Certification Page for Corrective Measures Study Report (Revision 1) — AOCs 569, 570, and 578, 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.

7/23/2004

Date

Contents

Contents, Continued

Contents, Continued

Appendices

Acronyms and Abbreviations

AOC	area of concern
BEQ	benzo(a)pyrene equivalents
BRAC	Base Realignment and Closure Act
BTEX	benzene, toluene, ethylbenzene, and xylene
CA	corrective action
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
CVOC	chlorinated volatile organic compound
DO	dissolved oxygen
EnSafe	EnSafe, Inc.
EPA	U.S. Environmental Protection Agency
ERD	Enhanced reductive dechlorination
ft bls	feet below land surface
ft msl	feet mean sea level
HI	Hazard Index
ILCR	Incremental Lifetime Cancer Risk
IM	interim measure
LUC	land use control
LUCMP	land use control management plan
μg/L	microgram per liter
mg/kg	milligram per kilogram
ml/g	milliliters per gram
MCL	maximum contaminant level
MCS	media cleanup standard
MEE	methane, ethane, and ethene
MNA	monitored natural attenuation
NAVBASE	Naval Base

Acronyms and Abbreviations, Continued

OSWER	Office of Solid Waste and Emergency Response
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbons
PCE	tetrachloroethene
PLFA	phospho-lipid fatty acid
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RGO	remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	soil screening level
TCE	trichloroethene
TOC	total organic carbon
UST	underground storage tank
VFA	volatile fatty acid
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. A RCRA Facility Investigation (RFI) for Areas of Concern (AOCs) 569, 570, and 578 in Zone E of the CNC was initially conducted by the Navy/EnSafe Inc. (EnSafe) team. The *Zone E RCRA Facility Investigation (RFI) Report, Revision 0* (EnSafe, 1997) provides a summary of RFI activities.

An RFI report addendum and a corrective measures study (CMS) work plan for AOCs 569, 570 and 578 were subsequently prepared by CH2M-Jones to complete the RFI process and initiate the CMS process (CH2M-Jones, 2003a). U.S. Environmental Protection Agency (EPA) comments on the *RFI Report Addendum and CMS Work Plan, Revision 0*, prompted the evaluation of an interim measure (IM) to excavate soil impacted by petroleum compounds in a localized area of AOC 569. An IM work plan was prepared to initiate additional delineation sampling and possible soil excavation. Pre-excavation delineation sampling conducted as part of the IM indicated that soil excavation was not warranted based on site-specific screening criteria. The responses to comments on the *RFI Report Addendum and CMS Work Plan, Revision 0*, were approved by the EPA in May 2003 and additional information requested in the comments was provided in the *RFI Report Addendum and CMS Work Plan, Revision 1* (CH2M-Jones, 2003b), submitted in October 2003.

The *RFI Report Addendum and CMS Work Plan, Revision 0*, presented the remedial action objectives (RAOs) and media cleanup standards (MCSs) proposed for AOCs 569, 570 and 578. This CMS report has been prepared by CH2M-Jones to complete the next stage of the CMS process for AOCs 569, 570 and 578.

The location of AOCs 569, 570, and 578 in Zone E is shown in Figure 1-1. Figure 1-2 shows an aerial photograph of the site.

1.1 Corrective Measures Study Report Purpose and Scope

This CMS report evaluates corrective measure alternatives for surface soil impacted by benzo(a)pyrene equivalents (BEQs), subsurface soil impacted by benzene, shallow groundwater impacted by tetrachloroethene (PCE), and deep groundwater impacted by trichloroethene (TCE) at AOCs 569, 570 and 578 in Zone E. These chemicals were identified as chemicals of concern (COCs) in the *RFI Report Addendum and CMS Work Plan, Revision 0,* for AOCs 569, 570 and 578.

This CMS report consists of: 1) the identification of a set of corrective measure alternatives that are considered to be technically appropriate for addressing soil and groundwater contamination; 2) an evaluation of the alternatives using standard criteria from EPA RCRA guidance; and 3) the selection of a recommended (preferred) corrective measure alternative for the site.

1.2 Background

This section of the CMS report presents background information on the facility, site history, and a summary of the nature and extent of 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 AOCs 569, 570 and 578. 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, 1997).

AOC 569 – Former Gas Station and Oil Storage; AOC 570 – Former Coal Storage Area; and AOC 578 – Transportation Shop and Garage

AOC 569 is a former gas station and oil storehouse previously housed in Building 1279 in Zone E of the CNC. The gas station was constructed in 1944 and consisted of two pumps and two 2,500-gallon underground storage tanks (USTs). In 1986, an additional 3,000-gallon UST was installed. During 1992, the site was demolished and the three USTs were removed by the Navy. During the tank closure activities, the tanks were pumped out and removed and the vent lines were filled. Contaminated soil was excavated and confirmatory soil samples were collected from the tank excavation area. The site was then backfilled with soil and resurfaced with asphalt.

The materials of concern for AOC 569 were identified in the RCRA Facility Assessment (RFA) (EnSafe, 1995) and include petroleum hydrocarbons; benzene, toluene, ethylbenzene, and xylene (BTEXs); polycyclic aromatic hydrocarbons (PAHs); volatile organic compounds (VOCs); and heavy metals. The CNC RCRA Permit identified AOC 569 as requiring an RFI.

AOC 570 is a former coal storage area in Zone E of the CNC. The coal storage facility extended from Building 30 to Sixth Avenue and from Carolina Avenue to Hobson Avenue. The coal storage area operated from 1919 to 1941. The RFA identified the materials of concern at AOC 570 to be metals. The CNC RCRA Permit identified AOC 570 as requiring an RFI.

AOC 578 is a former transportation shop and garage in Building 25 in Zone E of the CNC. The structure was built in 1940 and was originally used as an automobile garage and then later as a transportation and appliance maintenance shop. Building 25 recently included various facilities, such as an air-conditioning repair shop, a sheet metal shop, two electric shops, a paint shop, a sign shop, a carpenter's shop, a paper shredding area, an electrical maintenance shop, a tool room, and an emergency supply storage area. Currently Building 25 is used for equipment storage and as a transportation shop by the Environmental Enterprise Group (EEG). The CNC RCRA Permit identified AOC 578 as requiring an RFI.

Materials of concern identified in the RFA report (EnSafe, 1995) at AOC 578 include petroleum hydrocarbons, BTEXs, PAHs, VOCs, acids, and heavy metals. The CNC RCRA Permit identified AOC 578 as requiring an RFI.

The area of Zone E where AOCs 569, 570 and 578 are located is zoned CRD (Commercial Redevelopment District). Buildings 25 and 30 are scheduled to be demolished as part of a modification and realignment of Hobson Avenue with Avenue D. The modified road is expected to overlay part of the AOCs 569, 570 and 578 area. Figure A-1 in Appendix A shows the proposed new road alignment in the vicinity of AOC 569.

1.3 Summary of Site Conditions

1.3.1 Summary of Hydrogeologic Setting at AOCs 569, 570 and 578

AOCs 569, 570 and 578 are located in the northwestern portion of Zone E at the CNC, where the surface topography is relatively flat and elevations range between approximately 12 feet above mean sea level (ft msl) to approximately 6 ft msl near the Cooper River waterfront. Because the area is highly industrialized, surface water runoff is largely controlled by a system of stormwater sewers that discharge to the Cooper River.

Surface Geology

Due to the extensive surface soil disturbance at CNC during the history of its operations, the soils from land surface to depths of 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 the site, 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 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, which is a 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.

The Ashley Formation occurs at depths of approximately 16 to 43 feet below land surface (ft bls), except in the northern portion of Zone E, where it dips downward to the north, and was not encountered down to depths of 75 ft msl, probably due to secondary erosion. In the remainder of Zone E, the top of the Ashley Formation 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 consistency of the Ashley Formation is generally dense to stiff and plastic, with low vertical permeability.

In most areas of Zone E, the Ashley Formation is unconformably overlain by marine lagoon deposits of the Marks Head Formation, consisting of undifferentiated Tertiary age silts, clays and phosphatic sands of 2 to 15 feet in thickness.

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 is approximately 15 to 85 feet thick at CNC and is comprised mainly of Pleistocene age Wando Formation sands, silts, and clays, with varying amounts of organic matter, including peat.

At AOCs 569, 570 and 578, the Ashley Formation occurs at a depth of approximately 29 ft bls, based upon a boring completed during the installation of well E569GW01D in March 1996 during the RFI. This boring log is provided in Appendix A. The Ashley Formation at AOCs 569, 570 and 578 is overlain by several feet of undifferentiated Upper Tertiary age silt and sand, which is overlain by approximately 21 feet of interbedded clays and fine to medium-grained sands, which is overlain by about 4 feet of fill to the land surface.

Hydrogeology

The shallow aquifer system at AOCs 569, 570 and 578 is an unconfined water table aquifer occurring within the Quaternary sediments. The underlying low-permeability Ashley Formation member 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 AOCs 569, 570 and 578 area is approximately 25 feet, based on water level measurements in monitoring wells.

Regionally in Zone E, the shallow groundwater flows to the east, 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. However, because of extensive subsurface disturbances and the presence of underground utility lines and subsurface heterogeneities, the local groundwater flow direction at any specific site may vary significantly from the regional flow direction.

Locally at AOCs 569, 570 and 578, groundwater generally flows in a northeast direction, as indicated in potentiometric surface map (see Figure 1-3). Shallow groundwater is encountered at approximately 5 ft bls. At AOC 569, the shallow surficial aquifer is comprised of two permeable zones. A shallow permeable zone extends from land surface down to approximately 11 ft bls to 13 ft bls. Shallow wells at the site are screened in this zone. A clay layer extends from approximately 13 ft bls to 20 ft bls, below which a deeper permeable zone is encountered down to the Ashley Formation. Deep wells at AOC 569 are screened beneath the clay layer in this deeper zone.

The hydraulic conductivity of the shallow aquifer is approximately 10 feet/day. Based on the hydraulic gradients in the shallow portion of the surficial aquifer shown in Figure 1-3 (approximately 0.0044 foot/feet) and an assumed effective porosity of 0.40, a groundwater flow rate of 0.11 feet/day or 40 feet/year is calculated for the site.

Figure 1-3a shows the hydraulic gradients of the deeper portion of the shallow aquifer at the site. The contours are similar to the shallow groundwater contours shown in Figure 1-3.

The migration rate of organic chemicals in groundwater would be slower than the groundwater migration rate due to retardation effects resulting from interactions between the dissolved contaminants and aquifer media. A retardation factor (R) can be calculated from the expression:

R = 1 + [Pb * Kp/Pe], where

Pb = the bulk density of soil (1.6 to 1.8 grams/cm3)

Kp = the soil partition coefficient (estimated as organic carbon partition coefficient * percent total organic carbon [TOC]), and

Pe = effective porosity

Using the average Zone E subsurface soil TOC of 1.7 percent and an organic carbon partition coefficient of 365 milliliters per gram (ml/g) for PCE, a retardation factor of 29 can be calculated for the shallow aquifer. Based on this retardation factor, the PCE migration rate in groundwater at the site would be estimated at approximately 1.4 feet/year.

1.3.2 COC Distribution in Soil and Groundwater

COCs Identified in the RFI Report Addendum and CMS Work Plan

COCs identified in the *RFI Report Addendum and CMS Work Plan, Revision 0* (CH2M-Jones, 2003a) for soil at AOCs 569, 570 and 578 are BEQs for surface soil and benzene for subsurface soil. COCs identified in the *RFI Report Addendum and CMS Work Plan, Revision 0*, for groundwater at AOCs 569, 570 and 578 are PCE in shallow groundwater and TCE in deep groundwater.

COC Distribution in Soil

Figure 1-4 shows the soil sampling locations where COCs were detected above screening criteria.

BEQs in surface soil exceed the CNC basewide reference concentration of 1.304 milligrams per kilogram (mg/kg) at E570SB012 (at 3.97 mg/kg) and E578SB005 (at 1.62 mg/kg).

Benzene exceeds the site-specific soil screening level (SSL) of 0.078 mg/kg for the unpaved scenario at three subsurface soil samples: E569SB005 at 0.428 mg/kg, E569SB008 at 1.95 mg/kg, and E569SB010 at 0.805 mg/kg. The benzene detection of 1.95 mg/kg in the subsurface soil sample from E569SB008 also exceeds the site-specific SSL of 1.04 mg/kg for the paved scenario.

As shown on Figure A-1 in Appendix A, the only soil boring in which any COCs were present that will be impacted by the proposed road construction is E578SB005. The surface soil sample from this boring had an elevated detection of BEQs. Based on the proposed road alignment, this area may be paved over as part of the new road construction.

COC Distribution in Groundwater

Figures 1-5 and 1-6 show groundwater COC exceedances detected in monitoring wells at AOCs 569, 570 and 578 for PCE and TCE, respectively.

Tetrachloroethene (PCE)

Exceedances of the drinking water maximum contaminant level (MCL) for PCE have been detected in shallow monitoring wells E569GW001, E569GW002, E569GW003, E569GW004 and E570GW001.

The highest PCE concentration detected at the site was 92.2 micrograms per liter (µg/L) at E569GW003 during the November 2002 sampling event. This well was installed during March 2002 and PCE was detected in the March 2002 sampling event at 20.6 µg/L.

PCE detections in well E570GW001, which is upgradient of E569GW003, have fluctuated from detections below the laboratory detection limit to a maximum of 58 µg/L, which was detected during the March 1998 sampling event. The most recent PCE detection in this well was 3.5 µg/L (below the MCL) during November 2002.

PCE detections in the well E569GW004, which is the farthest downgradient well at AOC 569 from E569GW003, were 5.9 µg/L during March 2002 and 11.7 µg/L during the November 2002 sampling event.

The PCE exceedances of the MCL are limited to the shallow zone of the aquifer, based on the absence of PCE detections in the deep wells at the site

Figure 1-7 is an isoconcentration map for PCE concentrations at this site. The map indicates that a low-level PCE plume is migrating northeast in the direction of shallow groundwater flow. The leading edge of the plume boundary (the contour line indicating PCE concentrations below the MCL of 5 µg/L) appears to have reached an area just downgradient of E563GW005.

Trichloroethene (TCE)

Exceedances of drinking water MCLs for TCE at the site are limited to two monitoring wells: shallow well E569GW002 and deep well E570GW03D.

The highest TCE concentration detected at the site was 17µg/L at E570GW03D during the November 1996 sampling event. TCE concentrations in this well had decreased to 4.7 µg/L (below the MCL of 5 µg/L) during the most recent sampling event in November 2002.

The only TCE exceedance of the MCL in a shallow well occurred at E569GW002, which had a concentration of 6 µg/L during the November 1996 sampling event. The single low-level exceedance of the TCE MCL in the shallow well E569GW002 does not appear to be of concern, since the majority of the TCE detections in this well being below the MCL. TCE concentrations in two sampling events immediately following this exceedance were below laboratory detection limits and below the MCL in the subsequent (and last) two sampling events.

TCE presence in groundwater at this site appears to be localized near well E570GW03D and naturally degrading. None of the other deep wells at the site had TCE detections above laboratory detection limits.

1.4 Overall Approach for Selecting Candidate Corrective Measure Alternatives for AOCs 569, 570 and 578

Because of the small size of the AOCs 569, 570 and 578 site and the relatively low levels of contamination in surface soil and groundwater, the list of practicable remedial alternatives for this site are limited.

Because all of Zone E will undergo land use controls (LUCs) and the exceedances of screening criteria for BEQs in surface soil and benzene in subsurface soil are isolated, LUCs will be considered as a presumptive remedy for surface and subsurface soils. The low-level exceedances of the site-specific SSLs for benzene in subsurface soils are not impacting groundwater at the site and do not warrant removal. A comparison of the soil removal alternative with LUCs at several other sites at CNC have consistently shown that the LUC alternative is adequately protective of human health and the environment, less costly than soil excavation, and is a feasible alternative. Therefore, LUCs will be considered as a presumptive remedy for soils at this site. LUCs will preclude the property from being used for residential use, as well as require existing pavement cover in the area of subsurface soil exceedances of the SSL at the site to be maintained.

Two presumptive remedies will be considered for the groundwater COCs in the CMS:

- Monitored natural attenuation (MNA) with LUCs, and

- Enhanced In Situ Anaerobic Biodegradation of Chlorinated Volatile Organic Compound (CVOCs) with LUCs.

1.5 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 AOCs 569, 570 and 578, as well as 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 addressing CVOCs in groundwater.

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 CVOCs in groundwater based on a comparison of the alternatives.

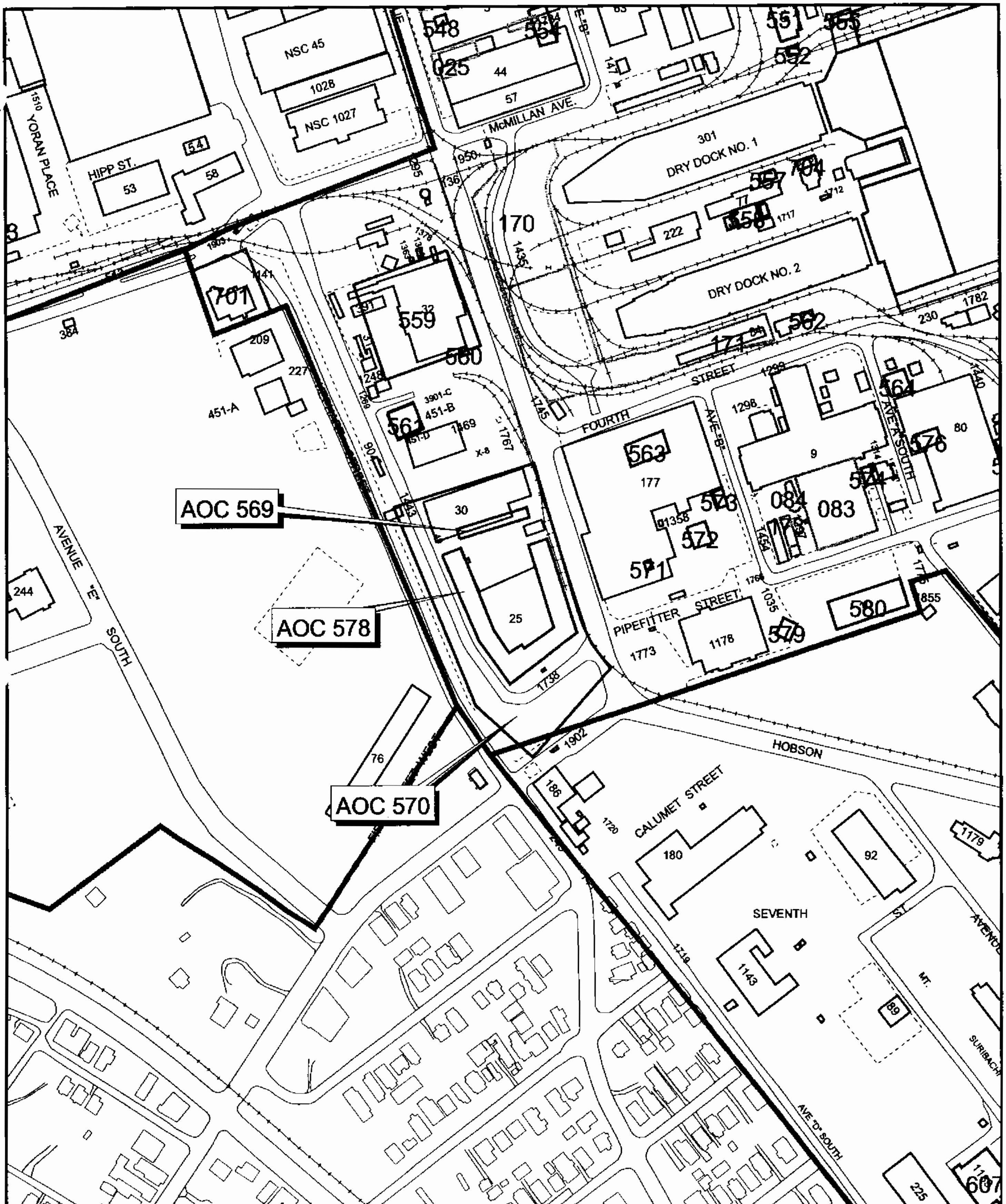
6.0 References — Lists the references used in this document.

Appendix A contains Figure A-1, which shows the proposed new road alignment in the vicinity of AOC 569, and Figure A-2 is a boring log for monitoring well E569GW01D.

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

Appendix C contains CH2M-Jones' responses to SCDHEC comments on *CMS Report, AOCs 569, 570, and 578, Zone E, Revision 0.*

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



Railroads
Fence
Roads
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 200 400 Feet

1 inch = 300 feet

Figure 1-1
Location of AOCs 569, 570 and 578
Zone E
Charleston Naval Complex

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NOTE: Aerial Photo Date is 1997

Figure 1-2
AOC 569 , 570, and 578
Site Map
Charleston Naval Complex

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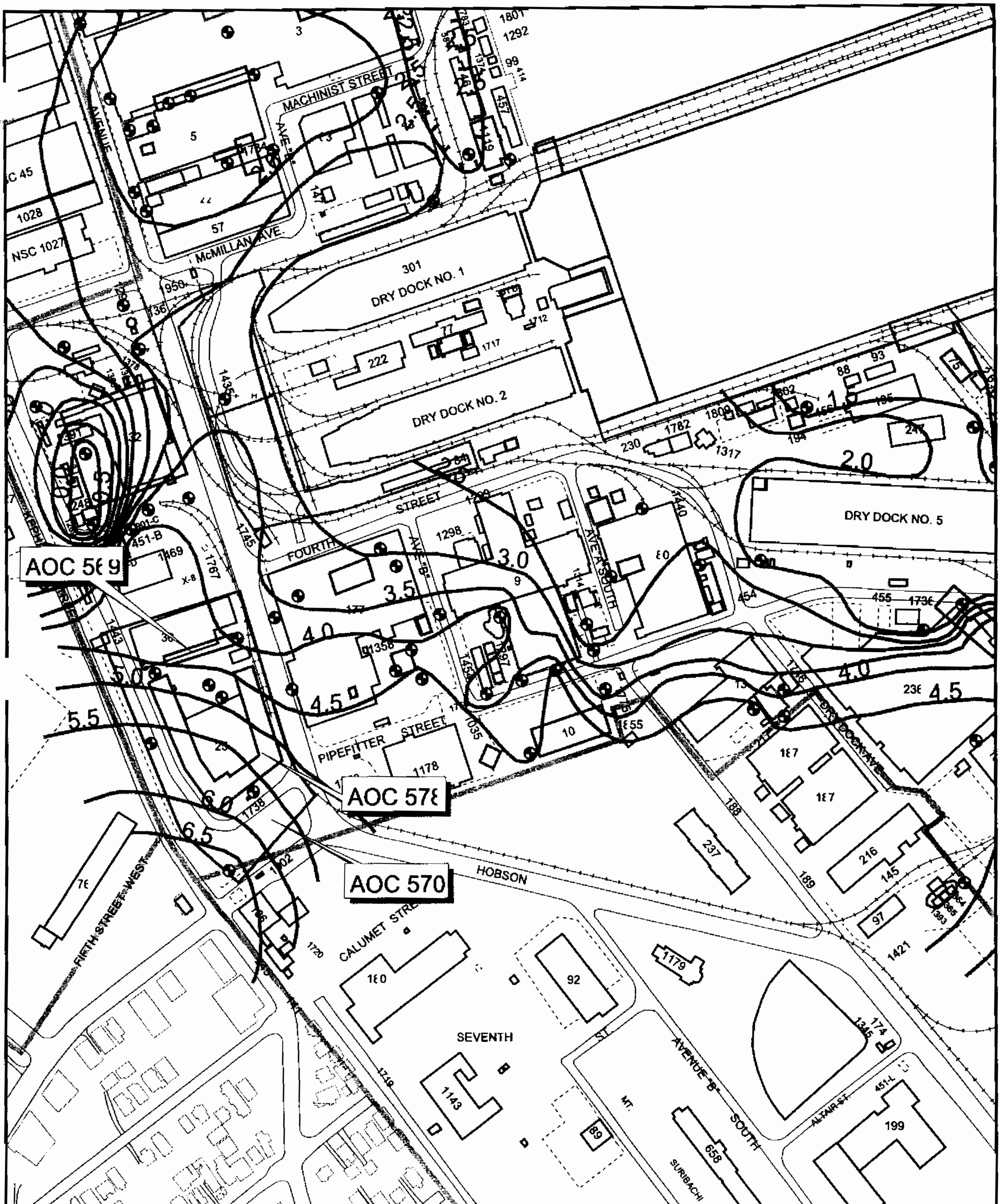
File Path: C:\18gis\Projects\Zone_E\AOC569_570_578\Aprs\aoc569_570_578figures.apr, Date: 12 Dec 2001 9:34, User: NMOUDRY, Figure x-x AOC 568, 570, and 578 sitemap



Shallow Groundwater Elevation (ft. above msl)
Shallow Groundwater Wells
Railroads
Fence
Roads
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 200 400 Feet

1 inch = 300 feet

Figure 1-3
Shallow Groundwater Contour Map, May 2002
AOCs 569, 570 and 578, Zone E
Charleston Naval Complex

CH2MHILL

NOTE: Original figure created in color

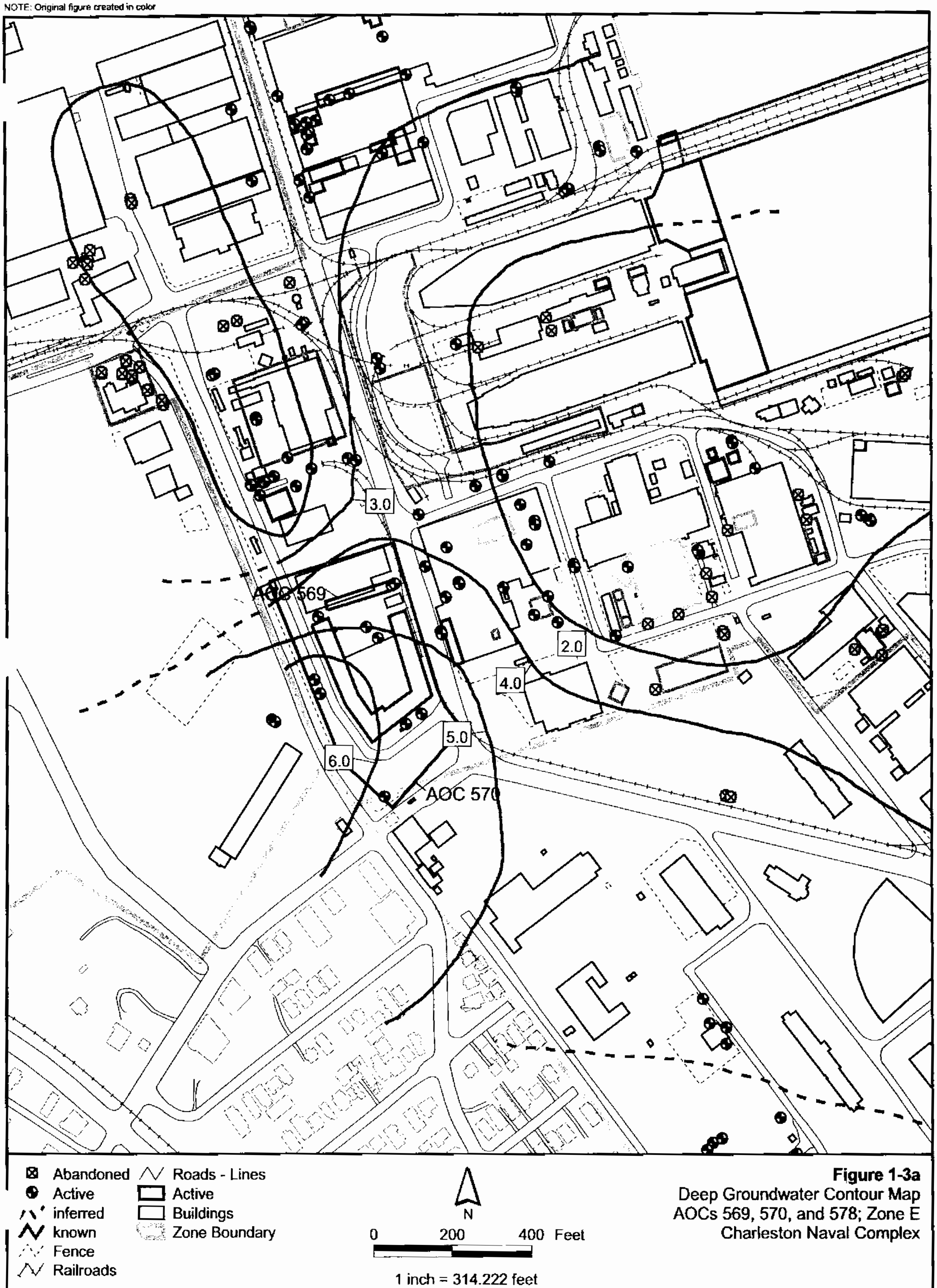
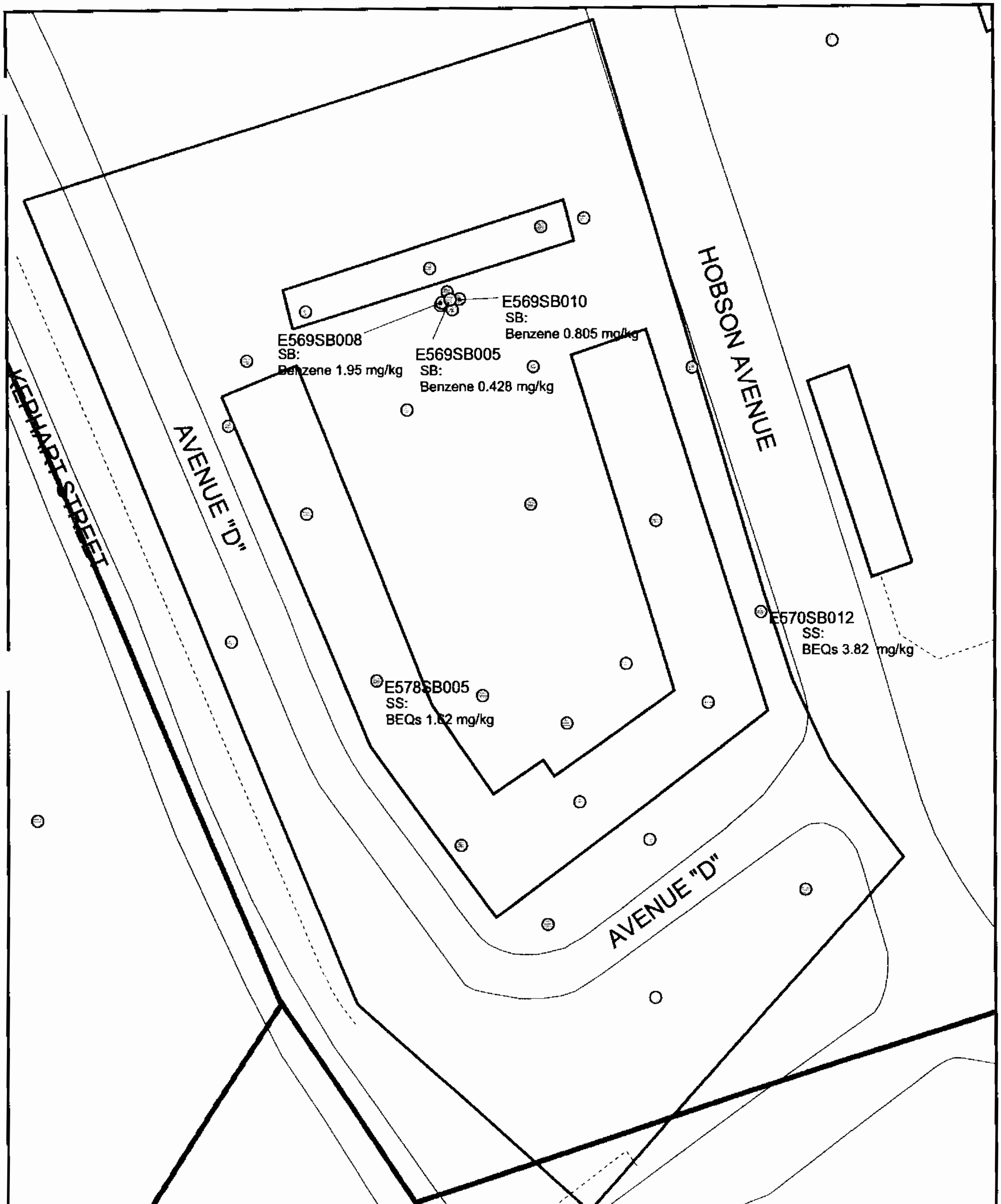


Figure 1-3a
Deep Groundwater Contour Map
AOCs 569, 570, and 578; Zone E
Charleston Naval Complex

File Path: c:\18gis\cnc\cnc-egis.apr, Date: 12 Jul 2004 15:45, User: DWILLIAM, EGIS: Charleston Naval Complex - Figure 1-3a Deep Groundwater Contour Map



Soil Sampling Locations
Roads
AOC Boundary
SWMU Boundary
Zone Boundary

SS: Surface Soil Sample
SB: Subsurface Soil Sample

N

0 60 120 Feet

1 inch = 74 feet

Figure 1-4
Soil Sampling Locations with COC Exceedances
AOCs 569, 570 and 578, Zone E
Charleston Naval Complex

CH2MHILL

Date: 27 Oct 2003 13:33 User: SNAIK1 EGIS: Charleston Naval Complex - Figure 1-3 Soil Sampling Locations with COC Exceedances

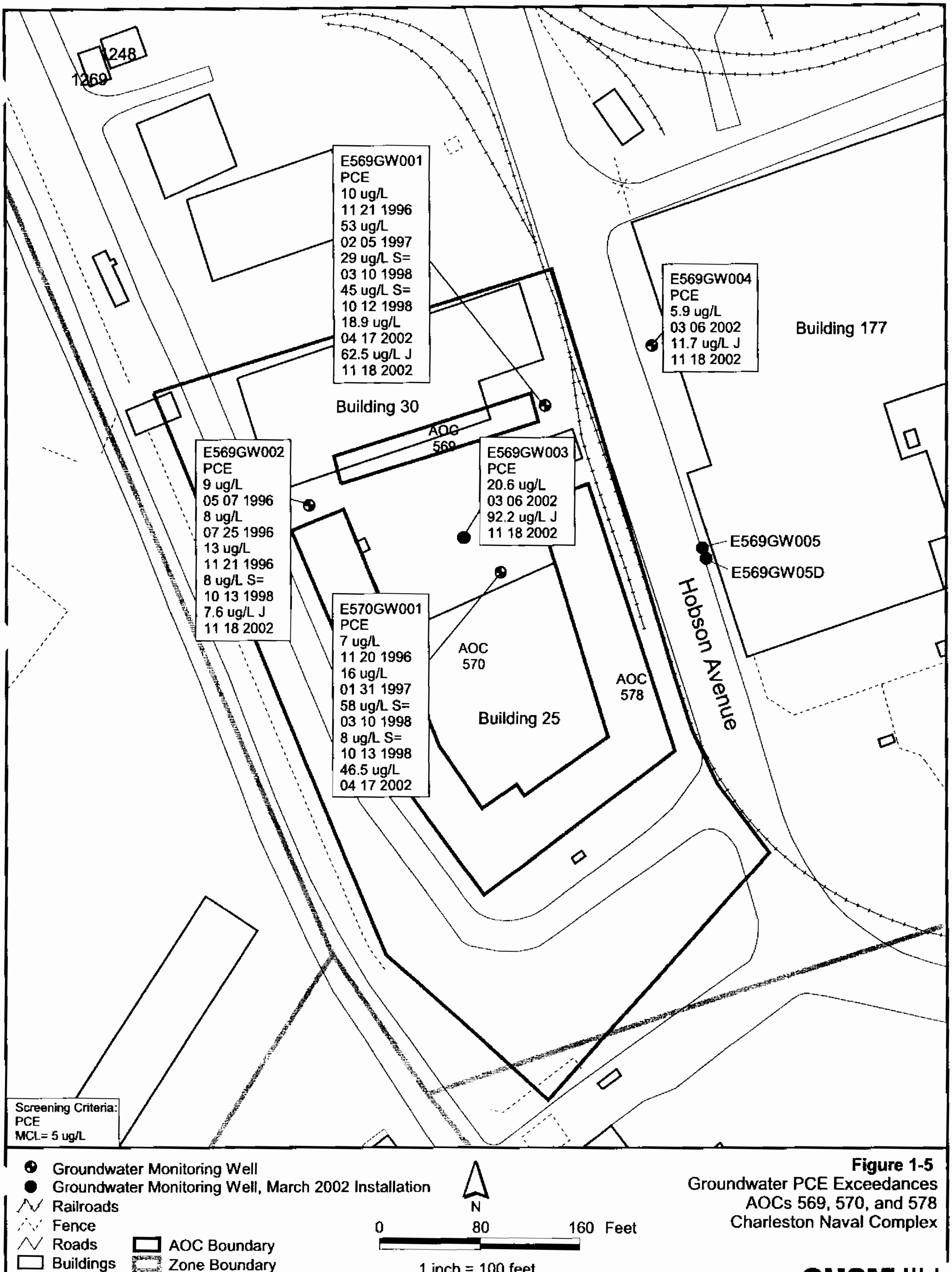


Figure 1-5
Groundwater PCE Exceedances
AOCs 569, 570, and 578
Charleston Naval Complex

CH2MHILL

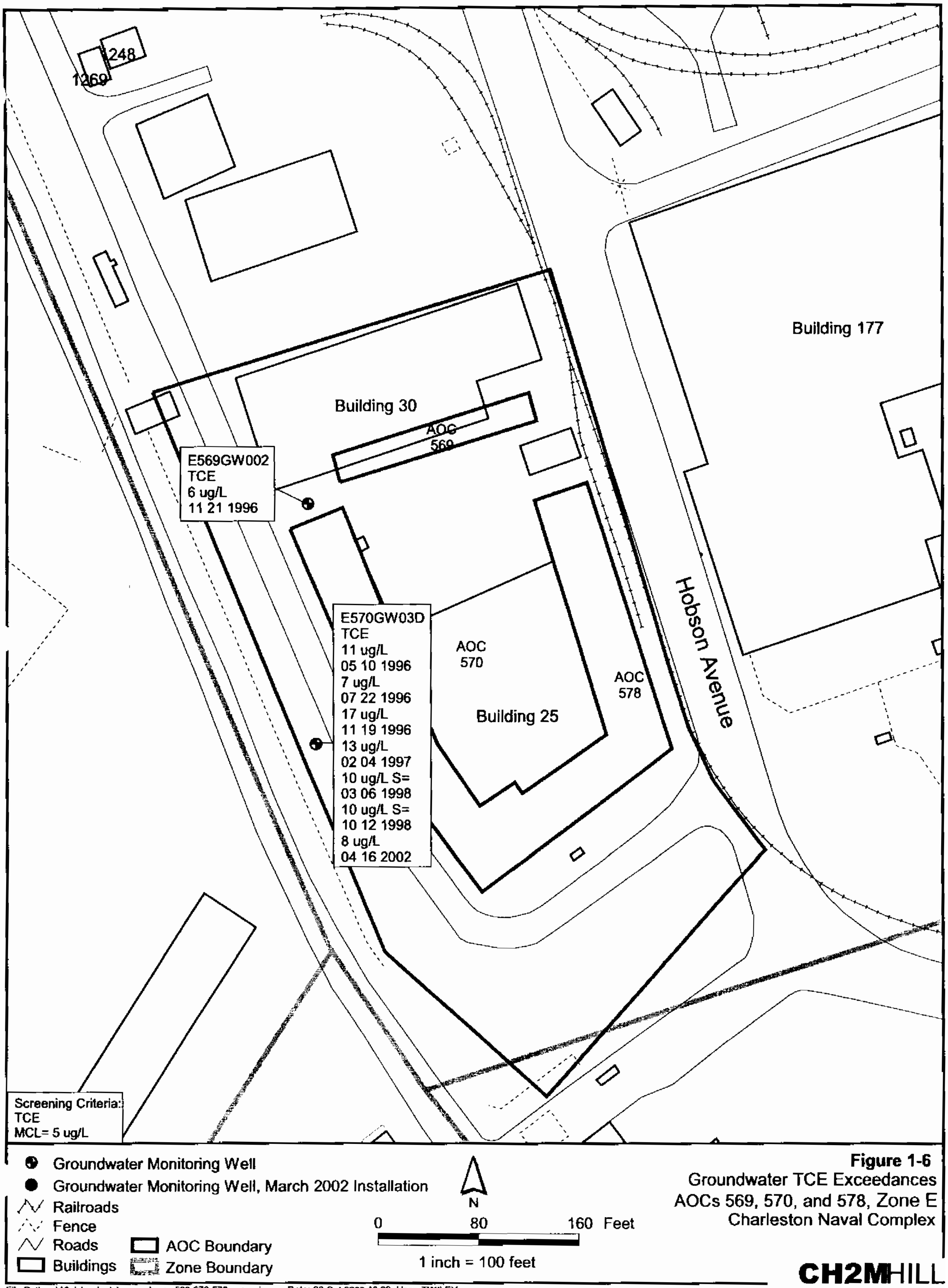


Figure 1-6
Groundwater TCE Exceedances
AOCs 569, 570, and 578, Zone E
Charleston Naval Complex

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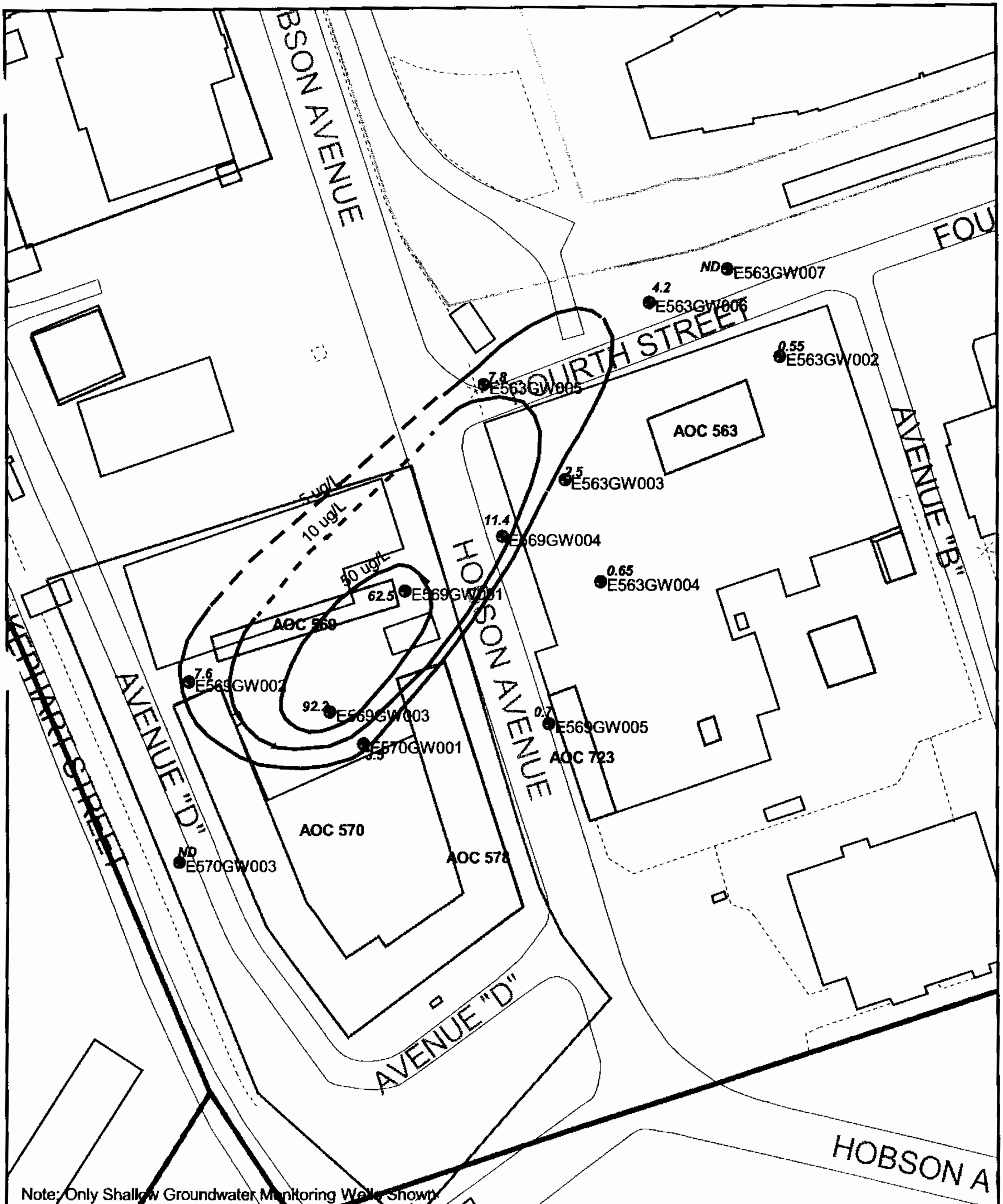

PCE Isoconcentration Contour with PCE Concentration (Nov 2002)
PCE Isoconcentration Contour (Inferred)
Shallow Groundwater Monitoring Well
92.2 PCE Concentration in Shallow Well
AOC Boundary
SWMU Boundary
Zone Boundary

N

0 90 180 Feet
1 inch = 115 feet

Figure 1-7
PCE Isoconcentration Contours
Shallow Zone of Surficial Aquifer
AOCs 569, 570 and 578, Zone E
Charleston Naval Complex

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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 RAOs identified for the surface soil and groundwater at AOCs 569, 570 and 578 are being chosen to prevent ingestion of soil and groundwater containing COCs and CVOCs at unacceptable levels. All of Zone E is expected to undergo LUCs, which will also apply to soils at this site.

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 AOCs 569, 570 and 578 are surface soil impacted by BEQs, subsurface soil impacted by benzene, shallow groundwater impacted by low levels of PCE and deep groundwater impacted by low levels of TCE. Because this site is located within a highly developed area of the CNC and there are no surface water bodies in the immediate vicinity of the site, ecological exposures were not considered applicable for evaluation.

For the chemicals identified as COCs in soil and shallow groundwater, the following MCSs are proposed:

COC	Target MCS
Soil	
BEQs	CNC Basewide BEQ Reference Concentration of 1.304 mg/kg for surface soil.
Benzene	Site-specific SSL for the unpaved scenario (0.078 mg/kg).
Groundwater	
PCE	MCL for PCE - 5 μg/L
TCE	MCL for TCE - 5 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 zinc-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

Section 3.0

3.0 Description of Candidate Corrective Measure Alternatives

3.1 Introduction

As indicated in Section 2.0, because all of Zone E will undergo LUCs and the exceedances of screening criteria for BEQs in surface soil and benzene in subsurface soil are isolated, LUCs are being chosen as the presumptive remedy for soils. Therefore, no evaluation or comparison of corrective measure alternatives for surface and subsurface soils have been described in this report.

Currently available groundwater remedial technologies were screened for applicability to the contaminants and physical conditions present at AOCs 569, 570 and 578, with only the most viable technologies known for effective treatment of CVOCs in groundwater selected for alternatives analysis. The CVOC exceedances in shallow groundwater are found mainly in the vicinity of wells E570GW001, E569GW001 and E569GW003, and around well E570GW03D in deep groundwater.

Two presumptive remedies will be considered for site groundwater in the CMS:

- MNA with LUCs, and
- Enhanced In Situ Anaerobic Biodegradation of CVOCs with LUCs.

The sections below describe each alternative in more detail.

3.2 Alternative 1: Monitored Natural Attenuation with Land Use Controls

3.2.1 Description of Alternative

Alternative 1 will allow the CVOCs to continue to naturally attenuate in the subsurface, with periodic monitoring of groundwater concentrations until the MCSs are reached, and will impose LUCs (such as a deed restriction) to restrict the installation of drinking water wells.

The collective effort of natural processes present in the aquifer, including volatilization, hydrolysis, dilution, dispersion, adsorption, and biotic and abiotic degradation, that reduce

CVOC concentrations is termed natural attenuation. MNA is a careful evaluation of natural attenuation mechanisms using monitoring. EPA has issued an Office of Solid Waste and Emergency Response (OSWER) Final Directive on Monitored Natural Attenuation (EPA, 1999), in which it recognizes that MNA is appropriate as a remedial approach, "where it can be demonstrated capable of achieving a site's remedial objectives within a time frame that is reasonable compared to that offered by other methods, and where it meets the applicable remedy selection criteria for that particular OSWER program." EPA clearly states its expectation that "monitored natural attenuation will be most appropriate when used in conjunction with active remediation measures (e.g., source control) or as a follow-up to active remediation measures that already have been implemented."

The low concentrations of CVOCs in groundwater indicate that a significant source area with high-level contamination is not present. Therefore, no source area treatment technologies are needed at this site. The nature and extent of CVOC exceedance of MCLs is briefly described below.

CVOCs in Shallow Groundwater

PCE is the only CVOC of concern in shallow groundwater. A single exceedance of the TCE MCL of 5 µg /L was detected in shallow well E569GW002 during the November 1996 sampling event, with subsequent TCE detections in this well being below the MCL or below the laboratory detection limits.

Concentrations of PCE in shallow groundwater are fairly low, with the highest PCE concentration detected being 92.2 µg/L at E569GW003 during the November 2002 sampling event. The concentrations of chlorinated solvent daughter products (TCE, 1,2-dichloroethene [1,2-DCE] and vinyl chloride [VC]) are significantly lower in this well. TCE was detected at 3.8 µg/L and 1,2-DCE was detected at 0.85 µg/L during this sampling event. Vinyl chloride was not detected above laboratory detection limits in this well.

Figure 1-7 shows the extent of the PCE plume at AOC 569 in the shallow aquifer. Based on the slow migration rate of PCE estimated for the shallow aquifer (less than 2 feet/year), the PCE plume is not expected to present a significant migration risk during the corrective measures implementation for this site.

CVOCs in Deep Groundwater

Exceedances of the TCE MCL were detected in only one deep groundwater well at the site, E570GW03D. The highest TCE concentration detected in this well was 17 µg/L during the November 1996 sampling event. TCE concentrations in this well have decreased to 4.3

μg/L (below the MCL of 5 μg/L) during the most recent detection from the November 2002 sampling event. TCE appears to be degrading naturally in this area.

Table 3-1 shows historical detections of these CVOCs in groundwater at AOCs 569, 570 and 578.

Under the natural attenuation alternative, the CVOC plume would be evaluated using a monitoring system designed to track the plume location and concentrations. Monitoring data would be compared to the predicted transport and fate of the CVOCs to check the accuracy of these predictions. In general, the MNA alternative consists of three major features:

- A designed monitoring program,
- A tracking and data evaluation program, and
- A contingency response plan in the event that the monitoring indicates downgradient migration of dissolved CVOCs.

The MNA alternative would be implemented in conjunction with a long-term monitoring plan. The purpose of the plan is to monitor plume migration over time and to verify that natural attenuation is occurring. The plan would specify existing wells located within, upgradient to, crossgradient to, and downgradient from the plume. Up to eight existing monitoring wells (shallow wells E569GW001, E569GW002, E569GW003, E569GW004, E570GW001, E563GW005 and deep wells E569GW01D and E570GW03D) will be monitored to assess natural attenuation. Because of the significant amount of data already available for the site, the monitoring plan would focus primarily on monitoring for the CVOCs. Field measurements, such as dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity, would continue to be monitored. Additional parameters, such as ferrous iron, common cations and anions, and dissolved ethene, ethane, and methane, might also be monitored occasionally, if additional information on these parameters is needed. The data would provide ongoing characterization of plume extent, groundwater quality, hydraulic gradients, ORP indicators, and indicators of biological degradation products of the CVOCs. As shown on the Zone E groundwater potentiometric surface map from 2002 (see Figure 1-3), hydraulic gradients across the site are quite low, and contaminant migration rates are on the order of a few feet per year towards Cooper River.

It is expected that the CVOC plume will slowly decrease in concentration as a result of natural attenuation. Additional contingency remedies would be considered if natural attenuation indicates low performance, as evidenced by increasing trends for total CVOC concentrations at the downgradient edge of the plume that significantly increase potential exposures or related risks. Existing data indicate that this scenario is not likely.

LUCs, such as deed restrictions, would be implemented to restrict the installation of drinking water wells at AOCs 569, 570 and 578. Such LUCs could be removed after CVOC concentrations have reduced to MCLs or lower. LUCs are currently planned for AOCs 569, 570 and 578, as well as the remainder of the Zone E industrial area.

3.2.2 Key Uncertainties

The uncertainties for the MNA alternative are not significant. Key uncertainties include monitoring well network effectiveness and confirming plume stability (that it is effectively biodegrading and not migrating). The existing monitoring well network is currently generally adequate to delineate groundwater conditions at the site. Continued water level measurements during the routine groundwater quality monitoring events will be utilized to determine whether any changes to the monitoring network, such as the addition of wells, are required. Uncertainties regarding plume stability will be determined during the continued monitoring of the plume and during the demonstration that contamination is not detected in the downgradient wells.

3.2.3 Other Considerations

LUCs restricting the use of groundwater at the site will be necessary during the MNA period until MCLs are achieved. The LUCs will also address the exposure pathways for BEQs in surface soils and benzene in subsurface soils.

3.3 Alternative 2: Enhanced In Situ Anaerobic Biodegradation with Land Use Controls

3.3.1 Description of Alternative

Technology Description

CVOCs have been shown to be biodegradable, primarily under anaerobic condition. The main CVOC biodegradation mechanism in anaerobic environments is reductive dechlorination, which involves the sequential replacement of chlorine atoms on the alkene molecule by hydrogen atoms.

In anaerobic reductive dechlorination, a carbon atom in the chlorinated solvent accepts an electron from an electron donor (reduction), causing the release of a chlorine atom (dechlorination). The more chlorine atoms a compound has, the more oxidized its carbon is, and therefore the more susceptible it is to reductive dechlorination. This results in sequential dechlorination of a contaminant. The general reductive dechlorination process results in the formation of breakdown products as detailed below:

PCE ⇒ TCE ⇒ DCE ⇒ vinyl chloride ⇒ ethene

The chlorinated ethenes serve as electron acceptors in these degradation reactions. This process is referred to as dehalorespiration. Organic carbon compounds such as sugars, alcohols, and fatty acids serve as electron donors.

Enhanced reductive dechlorination (ERD) would involve implementing more active measures in areas of elevated PCE concentration to accelerate the naturally occurring process. For anaerobic biodegradation to be successful, adequate quantities of electron donors, electron acceptors, and nutrients must come in contact with the active microbial consortia and the target contaminants. Not all natural groundwater systems have the essential microbiological organisms needed to achieved complete reductive dechlorination of PCE and TCE to ethene. One group of bacteria, *Dehalococcoides ethenogenes*, has been found to be capable of complete dechlorination. At some sites, the addition of a microbiological consortium containing *Dehalococcoides ethenogenes* may be an alternative to improve the degree of reductive dechlorination achieved.

Hydrogen is the electron donor used by *Dehalococcoides ethenogenes* and other micro-organisms in dehalorespiration. The hydrogen is released by the anaerobic fermentation of organic carbon. Other microbes, such as methanogens, compete with dehalorespiring bacteria for available hydrogen.

A commonly used approach for achieving ERD is biostimulation, which is providing a fermentable substance into the groundwater. Commonly used substrates include Hydrogen Release Compound® (a proprietary lactate polymer), molasses, lactate, and other readily biodegradable materials. Indigenous anaerobic microorganisms ferment these organic chemicals, resulting in the release of hydrogen. The hydrogen can then be used by organisms capable of dechlorinating CVOCs. However, not all substrates are equally effective at all sites. At some sites a particular substrate may be effective at allowing the microbes to achieve enhanced or complete dechlorination, while at other sites that same substrate may not be as effective. Thus, identifying an appropriate substrate is an important element of this process.

The addition of a substrate or other enhancements can be achieved through injection in conventional wells or by inserting the material(s) directly into the aquifer using direct-push technologies. The effectiveness of any enhancement or anaerobic reductive dechlorination is dependent on the ability to supply the rate-limiting reagent directly to the microorganisms and the presence of the appropriate microbes and hydrogeologic conditions.

At some sites, the activity of naturally occurring microorganisms is significantly reduced or potentially inhibited because of site geochemical conditions. This method of bioaugmentation may also be applicable if the appropriate bacteria are not present. Bioaugmentation involves the injection of a known microbial consortia of chlorinated solvent-degrading bacteria. Bioaugmentation with selected known chlorinated solvent-degrading consortia has been shown to be capable of completing dechlorination to ethene at a limited number of sites. Complete dechlorination has occurred at these sites when bioaugmentation with microbial cultures known to be capable of complete dechlorination has been employed. Bioaugmentation is considered potentially applicable in these special cases and can be evaluated through laboratory microcosm study or pilot testing.

3.3.2 Conceptual Approach to Implementing ERD

For the purpose of evaluating this alternative, it is assumed that one of the more widely effective substrates, such as lactate, would be a suitable electron donor and that it would be injected via conventional wells. If necessary, the system could also be bioaugmented with a commercially available bacterial consortium known to contain Dehalococcoides.

For this alternative, it is assumed that potassium lactate ($C_3H_5KO_3$) would be injected into three existing monitoring wells (shallow wells E569GW001, E569GW003, and E570GW001) in which PCE concentrations have historically exceeded the MCLs. Groundwater would be monitored downgradient of these wells to assess the effectiveness of this approach. Three additional monitoring wells (E569GW006, E569GW007 and E569GW008) screened in the shallow interval of the surficial aquifer would be installed approximately 10 ft downgradient of the injected wells to evaluate performance. The general location of these wells are depicted in Figure 3-1.

Lactate was selected as the presumed electron donor since it is an easily fermented substrate that has been effectively used at many sites and is easy to inject. Lactate solutions are easily handled and there is no health risk, since lactate exists naturally in the body and is used as a flavoring salt for food. Typically lactate can sustain fermentation for approximately 10 to 45 days once injected. The length of time required between injections depends on a variety of site-specific factors. For this application, it is assumed that up to six injections of lactate per well will be performed annually for 2 years.

Monitoring will be used to evaluate the impact on dissolved CVOC concentrations and the distribution and fermentation effects of lactate following the initial injection. Information obtained during the injection and performance monitoring period will be used to further enhance the design of future injection events. Parameters monitored would include field parameters (DO, oxidation-reduction potential, pH, temperature), VOCs, volatile fatty acids (VFAs), alkalinity, dissolved iron and related geochemical parameters.

It is expected that if this process is found to be effective, it would achieve a significant amount of reduction in VOC concentrations over the first several years in which it is implemented, with a declining amount of additional benefit in later years, once the portions of the residual plume that are amenable to this technology have been effectively treated. For this reason, an implementation period for the ERD process of up to 2 years has been assumed. However, the LUC element of this alternative would continue as long as necessary. Groundwater monitoring would also continue during the period after implementation of ERD, until CVOC concentrations are sustained below their respective MCLs.

3.3.3 Key Uncertainties

Key uncertainties for implementing ERD at AOCs 569, 570 and 578 include identification of an effective substrate that maximizes the degree of reductive dechlorination achieved and whether the natural bacterial consortium present at the site can achieve complete reductive dechlorination.

TABLE 3-1
Summary of Chlorinated VOC Concentrations Detected in Select Wells
Corrective Measures Study Report, AOCs 569, 570, and 578, Zone E, Charleston Naval Complex

			Tetrachloroethylene (PCE)		Trichloroethylene (TCE)		1,2-Dichloroethene (total)		Vinyl Chloride	
Sample ID	**Station ID**	**Date Collected**	**Result (µg/L)**	**Qualifier**	**Result (µg/L)**	**Qualifier**	**Result (µg/L)**	**Qualifier**	**Result (µg/L)**	**Qualifier**
569GW00101	E569GW001	05/03/1996	1.0	J	5.0	U	5.0	U	10.0	U
569GW00102	E569GW001	07/25/1996	5.0	U	5.0	U	5.0	U	10.0	U
569GW00103	E569GW001	11/21/1996	10.0	=	1.0	J	5.0	U	10.0	U
569GW00104	E569GW001	02/05/1997	53.0	=	3.0	J	5.0	U	10.0	U
569GW00101a	E569GW001	03/10/1998	29.0	S=	2.0	SJ	5.0	SU	5.0	SU
569GW00102a	E569GW001	10/12/1998	45.0	S=	2.0	SJ	5.0	SU	5.0	SU
569GW001M2	E569GW001	04/17/2002	18.9	=	4.7	J	0.9	J	10.0	U
569GW001M4	E569GW001	11/18/2002	62.5	J	2.8	J	0.7	J	10.0	UJ
569GW00201	E569GW002	05/07/1996	9.0	=	4.0	J	2.0	J	10.0	U
569GW00202	E569GW002	07/25/1996	8.0	=	3.0	J	5.0	U	10.0	U
569GW00203	E569GW002	11/21/1996	13.0	=	6.0	=	2.0	J	10.0	U
569GW00204	E569GW002	02/06/1997	2.0	J	5.0	U	5.0	U	10.0	U
569GW00201a	E569GW002	03/06/1998	4.0	SJ	5.0	SU	5.0	SU	5.0	SU
569GW00202a	E569GW002	10/13/1998	8.0	S=	4.0	SJ	5.0	SU	5.0	SU
569GW002M2	E569GW002	04/16/2002	2.1	J	1.0	J	0.3	J	10.0	U
569GW002M4	E569GW002	11/18/2002	7.6	J	4.3	J	1.4	J	10.0	UJ
569GW003M1	E569GW003	03/06/2002	20.6	=	2.4	J	0.9	J	10.0	U
569GW003M4	E569GW003	11/18/2002	92.2	J	3.8	J	0.9	J	10.0	UJ
569GW004M1	E569GW004	03/06/2002	5.9	=	0.5	J	5.0	U	10.0	U
569GW004M4	E569GW004	11/18/2002	11.7	J	0.8	J	0.7	J	10.0	U
569GW005M1	E569GW005	03/06/2002	1.1	J	5.0	U	5.0	U	10.0	U
569GW005M4	E569GW005	11/18/2002	0.7	J	5.0	U	5.0	U	10.0	U
569GW01D01	E569GW01D	05/09/1996	5.0	U	5.0	U	3.0	J	10.0	U
569GW01D02	E569GW01D	07/25/1996	5.0	U	5.0	U	1.0	J	10.0	U
569GW01D03	E569GW01D	11/21/1996	5.0	U	5.0	U	8.0	=	10.0	U
569GW01D04	E569GW01D	02/05/1997	5.0	U	5.0	U	3.0	J	10.0	U
569GW01D01a	E569GW01D	03/10/1998	5.0	SU	5.0	SU	6.0	S=	5.0	SU
569GW01D02a	E569GW01D	10/12/1998	5.0	SU	5.0	SU	7.0	S=	5.0	SU
569GW01DM4	E569GW01D	11/18/2002	5.0	U	0.4	J	9.6	J	10.0	U
570GW00101	E570GW001	05/02/1996	5.0	U	5.0	U	5.0	U	10.0	U

TABLE 3-1
Summary of Chlorinated VOC Concentrations Detected in Select Wells
Corrective Measures Study Report, AOCs 569, 570, and 578, Zone E, Charleston Naval Complex

			Tetrachloroethylene (PCE)		Trichloroethylene (TCE)		1,2-Dichloroethene (total)		Vinyl Chloride	
Sample ID	**Station ID**	**Date Collected**	**Result (µg/L)**	**Qualifier**	**Result (µg/L)**	**Qualifier**	**Result (µg/L)**	**Qualifier**	**Result (µg/L)**	**Qualifier**
570GW00102	E570GW001	07/23/1996	5.0	U	5.0	U	5.0	U	10.0	U
570GW00103	E570GW001	11/20/1996	7.0	=	5.0	U	5.0	U	10.0	U
570GW00104	E570GW001	01/31/1997	16.0	=	5.0	U	5.0	U	10.0	U
570GW00101a	E570GW001	03/10/1998	58.0	S=	1.0	SJ	5.0	SU	5.0	SU
570GW00102a	E570GW001	10/13/1998	8.0	S=	5.0	SU	5.0	SU	5.0	SU
570GW001M2	E570GW001	04/17/2002	46.5	=	2.3	J	0.4	J	10.0	U
570GW001M4	E570GW001	11/18/2002	3.5	J	5.0	U	5.0	U	10.0	UJ
570GW03D01	E570GW03D	05/10/1996	5.0	U	11.0	=	6.0	=	10.0	U
570GW03D02	E570GW03D	07/22/1996	5.0	U	7.0	=	5.0	=	10.0	U
570GW03D03	E570GW03D	11/19/1996	5.0	U	17.0	=	9.0	=	10.0	U
570GW03D04	E570GW03D	02/04/1997	5.0	U	13.0	=	8.0	=	10.0	U
570GW03D01a	E570GW03D	03/06/1998	5.0	SU	10.0	S=	5.0	SU	5.0	SU
570GW03D02a	E570GW03D	10/12/1998	5.0	SU	10.0	S=	7.0	S=	5.0	SU
570GW03DM2	E570GW03D	04/16/2002	5.0	U	8.0	=	6.3	=	10.0	U
570GW03DM4	E570GW03D	11/18/2002	5.0	U	4.7	J	6.3	J	10.0	UJ

Notes:

µg/L micrograms per liter

= 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.

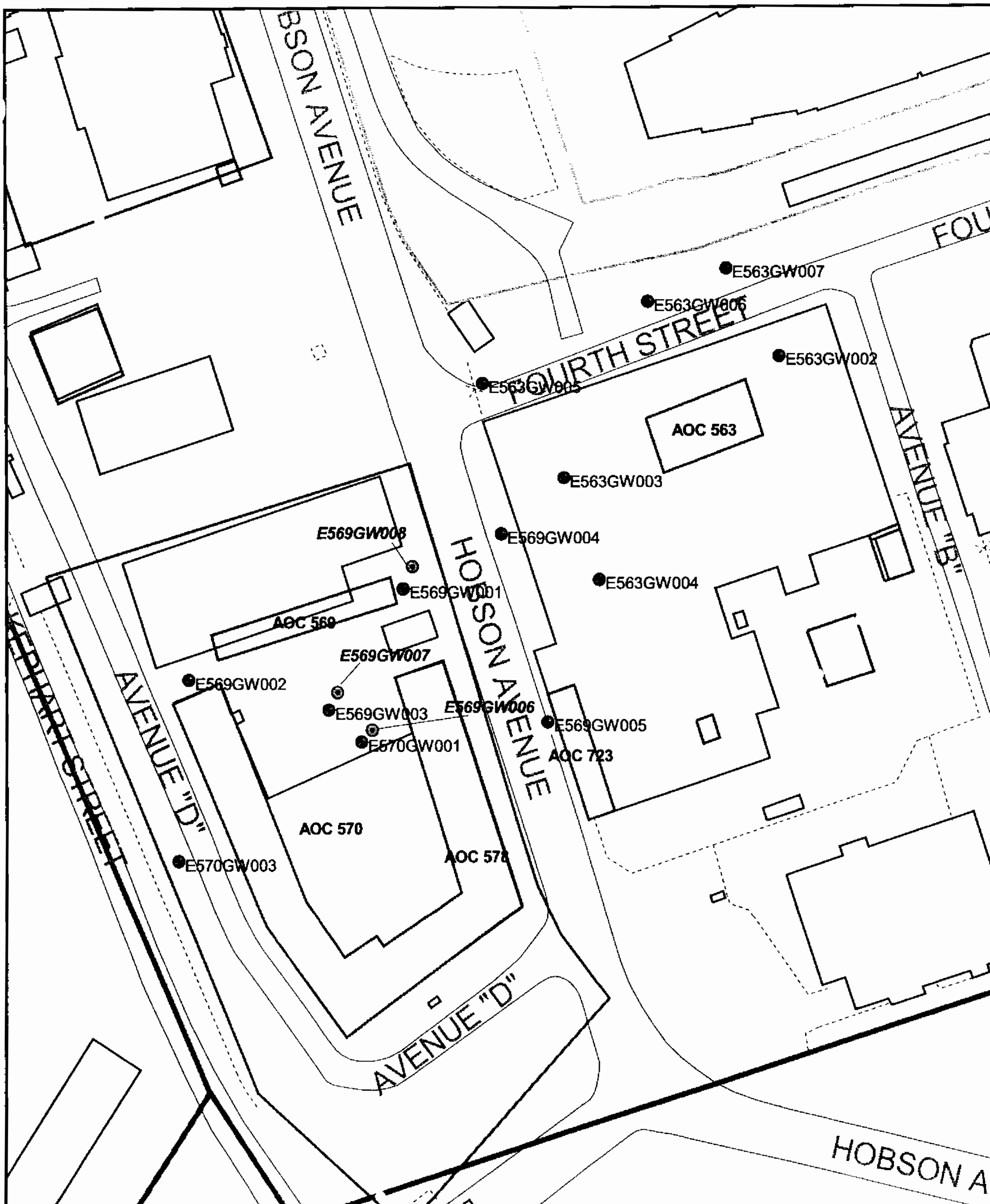
UJ Indicates that the concentration was not detected and is estimated.

S= Indicates that the data has not undergone final validation but the result is usable for screening and decision-making.

SJ Indicates that the data has not undergone final validation but the estimated analytical result shown is usable for screening and decision-making.

SU Indicates that the data has not undergone final validation but the detection below laboratory detection limit shown is usable for screening and decision-making.

1



◎ Proposed new wells to monitor ERD Treatment

● Shallow Groundwater Monitoring Well

N

0 60 120 Feet

1 inch = 115 feet

Figure 3-1
Locations of Proposed New Monitoring Wells
CMS Alternative 2, AOCs 569, 570 and 578
Charleston Naval Complex

CH2MHILL

Section 4.0

Section 4.0

4.0 Evaluation and Comparison of Corrective Measure Alternatives

The two corrective measure alternatives were evaluated relative to the evaluation criteria previously 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 B.

4.1 Alternative 1: Monitored Natural Attenuation with Land Use Controls

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 AOCs 569, 570 and 578, and other areas. The plan will be developed outside the scope of this CMS. Periodic groundwater monitoring will be performed until results indicate that the natural attenuation is considered complete and CVOC concentrations are below MCLs, estimated to be no more than 5 years at this site. Samples will be collected from eight existing monitoring wells (shallow wells E569GW001, E569GW002, E569GW003, E569GW004, E570GW001, E563GW005 and deep wells E569GW01D and E570GW03D) on an annual basis, and the samples will be analyzed for CVOCs. Selected MNA parameters will be analyzed, as needed, in the groundwater samples. Standard field parameters (DO, ORP, turbidity, temperature) will be monitored in all wells. For cost estimating purposes, monitoring will be planned for a 20-year period. Table 4-1 shows the wells to be sampled and the sampling parameters.

4.1.1 Protection of Human Health and the Environment

Alternative 1 is effective at protecting human health because it uses LUCs to prevent the ingestion of, and direct contact with, groundwater. Based on the slow migration rate of PCE (estimated at less than 2 feet /year), it is likely that this plume will naturally attenuate before representing a threat to the Cooper River.

4.1.2 Attain MCS

Alternative 1 is expected to eventually attain the MCS. The time frame required to achieve MCLs in all wells is difficult to predict. Given the relatively low concentrations present and low migration rates, this is estimated to be no greater than 10 to 20 years.

4.1.3 Control the Source of Releases

There are no ongoing sources of releases at AOCs 569, 570 and 578.

4.1.4 Compliance with Applicable Standards for the Management of Generated Wastes

Alternative 1 does not generate any wastes that require special management. The primary generated waste would be purge water from monitoring wells, which is easily managed to applicable standards.

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

Alternative 1 has adequate long-term reliability and effectiveness. However, if monitoring well sampling results indicated that unexpected migration of the groundwater plume had occurred, additional corrective measures would likely be necessary.

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

Alternative 1 relies on natural attenuation to reduce the toxicity, mobility, and volume of the contaminated groundwater.

4.1.7 Other Factors (c) Short-term Effectiveness

Through the implementation of LUCs, Alternative 1 has short-term effectiveness in preventing ingestion of, or contact with, the contaminated groundwater. No significant short-term risks would be created using this alternative.

4.1.8 Other Factors (d) Implementability

Alternative 1 is easily implemented since it requires only the implementation of LUCs and an appropriate monitoring well program.

4.1.9 Other Factors (e) Cost

Alternative 1 is the least costly to implement since it requires no construction of treatment facilities or disposal of wastes. The significant cost component of this alternative is groundwater monitoring.

Using the assumptions described earlier, the total present value of this alternative is $150,000.

4.2 Alternative 2: Enhanced In Situ Anaerobic Biodegradation with LUCs

A presumptive approach of enhanced in-situ aerobic biodegradation (via ERD) using one of the more widely effective substrates, such as lactate, was assumed for this alternative. The following additional assumptions were made:

- A base-wide LUCMP will be developed for the CNC. The plan will allow for restrictions on the use of groundwater at AOCs 569, 570 and 578 and other areas. The plan will be developed outside the scope of this CMS.
- The substrate will be injected into the three existing shallow wells E569GW001, E569GW003, and E570GW001. Samples will be collected from up to four additional groundwater wells on an annual basis and analyzed for the COCs. Selected MNA parameters will be analyzed, as needed, in the groundwater samples. Standard field parameters (DO, ORP, turbidity, temperature) will also be monitored.

Table 4-2 shows the wells to be sampled and the sampling parameters.

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 prevent the ingestion of, and direct contact with, groundwater during the time period when groundwater CVOC concentrations are greater than the MCS.

4.2.2 Attainment of MCSs

Alternative 2 is expected to eventually attain the MCS. The time frame required to achieve MCLs in all wells is difficult to predict. Given the relatively low concentrations present and low migration rates and assuming that anaerobic biodegradation can be effectively stimulated, this is estimated to be no greater than 5 to 15 years.

4.2.3 Control the Source of Releases

There are no ongoing sources of releases identified at AOCs 569, 570 and 578; therefore, this issue is not applicable.

4.2.4 Compliance with Applicable Waste Management Standards

This approach will generate minimal waste during implementation, limited to solid waste associated with well drilling and well development and purge water. Soil cuttings from monitoring well installation will be sampled and analyzed for waste characterization parameters prior to acceptance from a permitted facility. Liquid wastes will be disposed of in accordance with applicable standards.

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

Alternative 2 has long-term reliability because of the implementation of LUCs and permanent biodegradation of the COCs.

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

Alternative 2 reduces the toxicity, mobility, and volume of the contaminated groundwater via biodegradation.

4.2.7 Other Factors (c) Short-term Effectiveness

Because of the implementation of LUCs, this alternative will have short-term effectiveness in preventing ingestion of or contact with the contaminated groundwater. No unmanageable hazards would be created during its implementation.

4.2.8 Other Factors (d) Implementability

This alternative is relatively easily implemented.

4.2.9 Other Factors (e) Cost

Appendix B presents the overall cost estimate for implementing this remedy. The total present value of Alternative 2 is $247,000.

4.3 Comparative Evaluation of Corrective Measure Alternatives

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

1

TABLE 4-1
Sampling and Analysis SCHEMES for CMS Alternatives 1 and 2
Corrective Measures Study Report, AOCs 569, 570, and 578, Zone E, Charleston Naval Complex

Monitoring Well ID	Sampling Parameters
CMS ALTERNATIVE 1 (MNA) (Years 0-20)	
E569GW001 E569GW002 E569GW003 E569GW004	Field Measurement - DO, ORP, pH, temperature, turbidity, and specific conductance Offsite Laboratory Analysis - VOCs
E570GW001	
E569GW01D	
E570GW03D	
E563GW005 and E563GW006	
CMS ALTERNATIVE 2 (ERD)	
Baseline Characterization Sampling and Analysis	
E569GW001	VOCs, dissolved iron and manganese (field filtered), sulfate/sulfide, TOC, DHE (via Real Time PCR), phospholipid fatty acids (PLFAs), volatile fatty acids (VFAs), MEE, alkalinity
E569GW003	VOCs, dissolved iron and manganese (field filtered), sulfate/sulfide, TOC, DHE (via Real Time PCR), PFLAs, VFAs, MEE, alkalinity
E570GW001	VOCs, dissolved iron and manganese (field filtered), sulfate/sulfide, TOC, DHE (via Real Time PCR), PFLAs, VFAs, MEE, alkalinity
E569GW002	VOCs
E569GW004	VOCs
E563GW005	VOCs
E569GW006 (new well)	VOCs, dissolved iron and manganese (field filtered), sulfate/sulfide, TOC, DHE (via Real Time PCR), PFLAs, VFAs, MEE, alkalinity
E569GW007(new well)	VOCs, dissolved iron and manganese (field filtered), sulfate/sulfide, TOC, DHE (via Real Time PCR), PFLAs, VFAs, MEE, alkalinity
E569GW008 (new well)	VOCs, dissolved iron and manganese (field filtered), sulfate/sulfide, TOC, DHE (via Real Time PCR), PFLAs, VFAs, MEE, alkalinity
Post-Injection Monitoring for CMS Alternative 2 (YEARS 1 AND 2)	
Monthly Parameters (Months 1, 2, 3, 4, 5, and 6)	
E569GW006, E569GW007 and E569GW008	DO, ORP, pH, temperature, and specific conductance VOCs Methane, ethane, and ethene (MEE) Volatile fatty acids (VFA)

TABLE 4-1
Sampling and Analysis SCHEMES for CMS Alternatives 1 and 2
Corrective Measures Study Report, AOCs 569, 570, and 578, Zone E, Charleston Naval Complex

Monitoring Well ID	Sampling Parameters
	Total Organic Carbon (TOC)
Bi-Monthly Parameters (Months 2, 4, and 6)	
E569GW006, E569GW007 and E569GW008	All Monthly Parameters (see above)
	Sulfate
	Sulfide
	Dissolved iron (field filtered)
	Dissolved manganese (field filtered)
	Alkalinity
	DHE
	PFLAs
Long-term Monitoring for CMS Alternative 2 (Years 3-20)	
E569GW001, E569GW002, E569GW003, E569GW004,	CVOCs (PCE, TCE, 1,2-DCE, Vinyl Chloride)
E570GW001,	
E563GW005 and E563GW006	

1

TABLE 4-2
Detailed Analysis of Source Control Corrective Measure Alternatives
Corrective Measures Study Report/Pilot Study Work Plan, AOCs 569, 570 and 578, Zone E, Charleston Naval Complex

Evaluation Criteria	Alternative 1: Monitored Natural Attenuation and LUCs	Alternative 2: Enhanced In Situ Anaerobic Biodegradation of CVOCs and LUCs
Protection Of Human Health and the Environment	Process will be protective of human health and the environment.	Process will be protective of human health and the environment.
Attainment of Media Cleanup Standards	Alternative can potentially significantly reduce VOC concentrations at site; however, it is not expected to achieve MCSs throughout the entire plume.	Alternative can potentially significantly reduce VOC concentrations at site; however, it is not expected to achieve MCSs throughout the entire plume.
Control of the Source of Release	No release source identified. Therefore, this is not applicable.	No release source identified. Therefore, this is not applicable.
Compliance with Applicable Waste Management Standards	Not expected to accumulate significant quantities of waste requiring management.	Not expected to accumulate significant quantities of waste requiring management.
Long-Term Reliability and Effectiveness		
Magnitude of Residual Risk	Minimal residual risk due to LUCs, gradual reduction of potential risk within areas of elevated VOC concentration in groundwater	Minimal residual risk due to LUCs, significant reduction of potential risk within areas of elevated VOC concentration in groundwater.
Adequacy of Reliability of Controls	Expected to provide adequate control over the long term.	Expected to provide adequate control over the long term.
Reduction of Toxicity, Mobility, or Volume of Wastes		
Amount of Hazardous Materials Anticipated to be Destroyed/Treated	If properly implemented, the alternative is expected to reduce volume and mass of CVOCs.	If properly implemented, the alternative is expected to reduce volume and mass of CVOCs.

TABLE 4-2
Detailed Analysis of Source Control Corrective Measure Alternatives
Corrective Measures Study Report/Pilot Study Work Plan, AOCs 569, 570 and 578, Zone E, Charleston Naval Complex

Evaluation Criteria	Alternative 1: Monitored Natural Attenuation and LUCs	Alternative 2: Enhanced In Situ Anaerobic Biodegradation of CVOCs and LUCs
Degree and Quantity of Reduction	Low to moderate. Alternative has the long-term potential to decrease dissolved contaminant concentration.	Moderate. Process is expected to reduce CVOC contaminant concentrations.
Irreversibility of Reduction	High. Biodegradation of CVOCs via reductive dechlorination is irreversible.	High. Biodegradation of CVOCs from groundwater is irreversible.
Type and Quantity of Treatment Residuals	Minimal treatment residuals is anticipated.	Minimal treatment residuals is anticipated.
Preference for Treatment as a Principal Element	Natural treatment is a component of this alternative.	Treatment is the principal component of this alternative.
Short-Term Effectiveness		
Protection of Workers During Remedial Action Construction	Implementation poses a low degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.	Implementation poses a minimal degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.
Protection of Community During Remedial Action	Implementation poses a minimal degree of safety or health hazards to the CNC community.	Implementation poses a minimal degree of safety or health hazards to the CNC community.
(Short-Term Effectiveness)		
Environmental Impacts of Remedial Action	Process should not create adverse impacts on the environment.	Process should not create adverse impacts on the environment.
Implementability		
Technical Feasibility	High. Except for the new innovative analytical techniques. Process uses conventional and readily available technology.	High. Except for the new innovative analytical techniques. Process uses conventional and readily available technology.

TABLE 4-2
Detailed Analysis of Source Control Corrective Measure Alternatives
Corrective Measures Study Report/Pilot Study Work Plan, AOCs 569, 570 and 578, Zone E, Charleston Naval Complex

Evaluation Criteria	Alternative 1: Monitored Natural Attenuation and LUCs	Alternative 2: Enhanced In Situ Anaerobic Biodegradation of CVOCs and LUCs
Administrative Feasibility	High. Few major administrative issues	High. Will require UIC permit. Pilot test will be required as part of the design process.
Estimated Costs[a]		
Capital Cost	$22,500	$24,300
Annual O&M Cost	$5,500 (Years 1-20)	$57,000 (Years 1-2) $5,500 (Years 3-20)
Total Cost	$150,000	$247,000

[a] Order-of-magnitude level cost estimates with expected accuracy of plus 50 to minus 30 percent.

[b] Assumes 3.2 percent discount rate, 5-year operation period, and annual sampling for 20 years.

[c] Assumes 3.2 percent discount rate and annual sampling for 20 years.

Section 5.0

5.0 Recommended Corrective Measure Alternative

Two corrective measure alternatives were evaluated for groundwater COCs using the criteria described in Section 2.0 of this CMS report: Alternative 1: Monitored Natural Attenuation with LUCs, and Alternative 2: Enhanced In Situ Anaerobic Biodegradation with LUCs.

The RAOs identified for groundwater at AOCs 569, 570 and 578 are: 1) to prevent ingestion and direct/dermal contact with groundwater or surface soil having unacceptable carcinogenic or noncarcinogenic risk; 2) to prevent migration to offsite areas; and 3) to restore the aquifer to beneficial use.

Based on the alternative evaluations and RAOs for the site and current uncertainties associated with each alternative, the preferred corrective measure alternative is Alternative 1: Monitored Natural Attenuation with LUCs. Alternative 1 would provide protection of human health and the environment by maintaining the current and planned future use of the site as industrial while the contaminants naturally degrade to non-toxic end products. Limitations would prevent residential and other unrestricted land use, including installation of water supply wells that could expose sensitive populations.

An LUCMP is being developed for the industrial areas of the CNC, and AOCs 569, 570 and 578 will be added to the plan. The LUCMP will limit future site activities to those that would limit exposure to groundwater. Current data indicate that the contaminants are not migrating significantly, and based on historical detections of these contaminants in groundwater, are expected to continue not to migrate noticeably. 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, AOCs 569, 570 and 578., Zone E, Charleston Naval Complex, Revision 0.* May 2003a.

CH2M-Jones. *RFI Report Addendum and CMS Work Plan, AOCs 569, 570 and 578., Zone E, Charleston Naval Complex, Revision 1.* October 2003b.

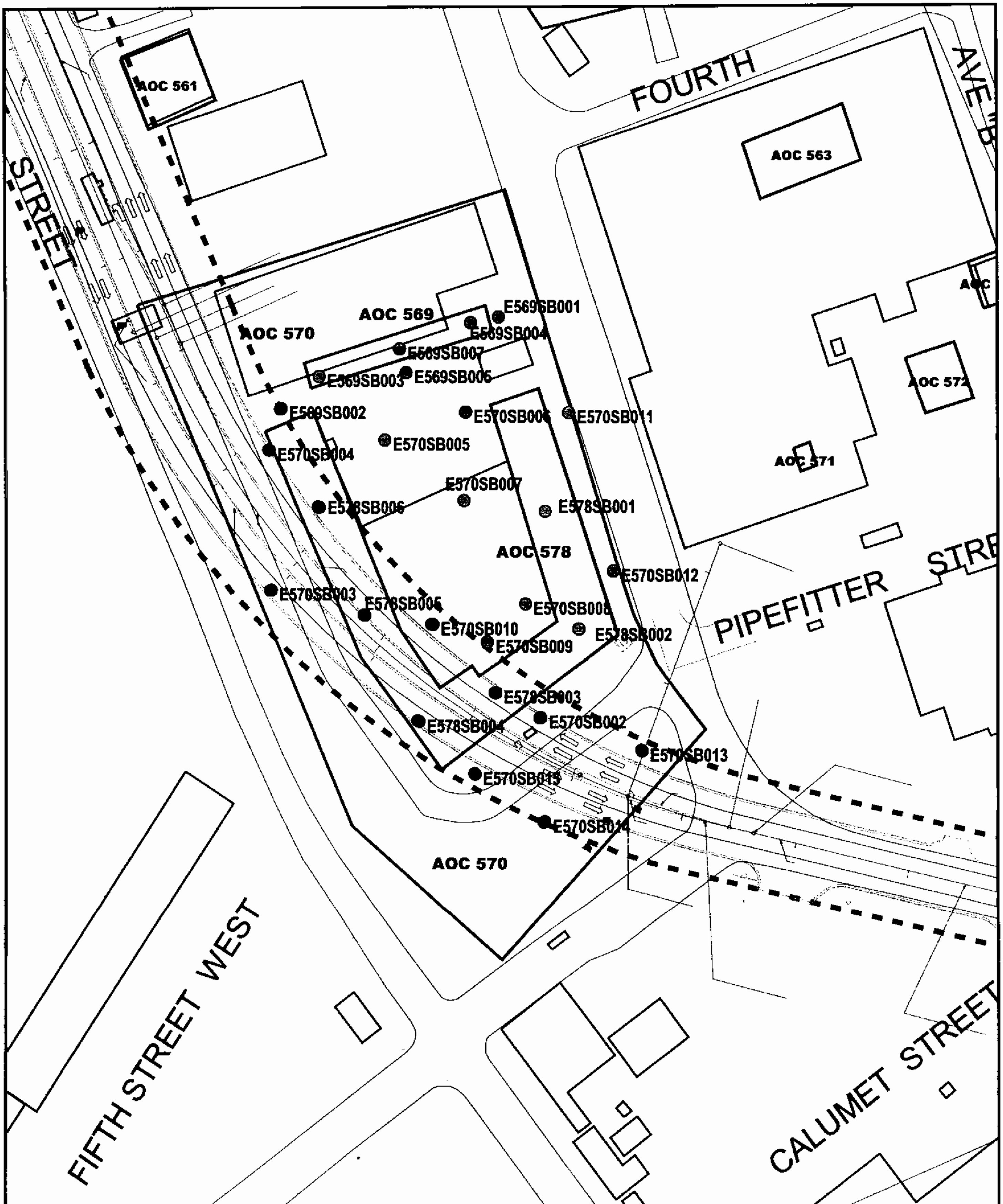
EnSafe Inc. *Zone E RFI Report, Revision 0, NAVBASE Charleston.* November 1997.

EnSafe/Allen & Hoshall. *Final RCRA Facility Assessment, Naval Base Charleston.* June 1995.

South Carolina Department of Health and Environmental Control, Final RCRA Part B Permit No. SC0 170 022 560.

U.S. Environmental Protection Agency (EPA). Draft Final OSWER Directive on Monitored Natural Attenuation. 1997.

Appendix A



AOC Boundary
SWMU Boundary
RFI Soil Sampling Location
RFI Soil Sampling Location within Proposed Realignment Footprint
Outer Boundary of Proposed Realignment Footprint

Figure A-1
RFI Soil Sampling Locations
Potentially Impacted by
Proposed Realignment of Hobson Ave
AOCs 569, 570 & 578, Zone E
Charleston Naval Complex

CH2MHILL

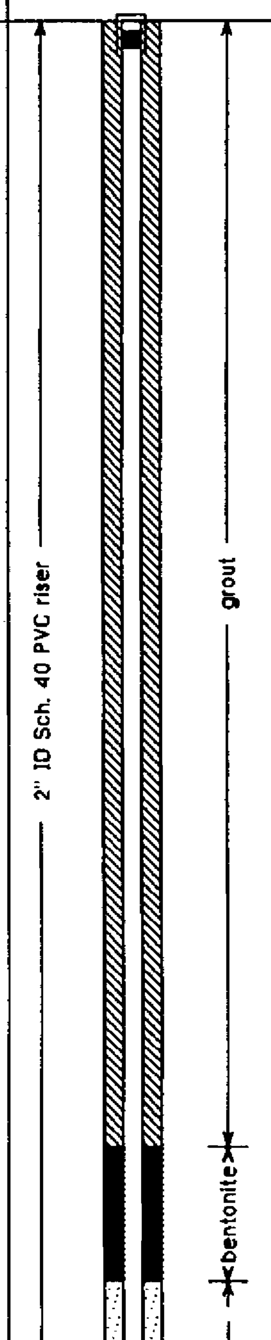
EnSafe/Allen & Hoshall

Monitoring Well NBCE56901D

Project: ZONE E – Naval Base Charleston	Coordinates: 2316803.72 E, 375545.55 N
Location: Charleston, SC	Surface Elevation: 10.5 feet msl
Started at 1055 on 1-21-96	TOC Elevation: 10.25 feet msl
Completed at 1155 on 1-21-96	Depth to Groundwater: 6.16 feet TOC Measured: 3/13/96
Drilling Method: Rotasonic (6.5" OD casing, 3.8" ID coring bit)	Groundwater Elevation: 4.09 feet msl
Drilling Company: Alliance Environmental (SC Cert# 889)	Total Well Depth: 31.0 feet bgs
Geologist: T. Kafka	Well Screen: 21.0 to 30.5 feet bgs

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Surface conditions: asphalt	
							GM / GC	Gravel: 1-2 cm size gravel in tan, fine to medium sandy matrix with clay and silt, moist, occasional asphalt pieces.	9
							GC / SC	Sand: bright orange, very fine to fine, clayey, small asphalt pieces.	8.5
							CL / CH	Clay: red-orange to orange, 20% very fine to fine sand, silty, medium to high plasticity, firm to stiff, moist to wet.	7.5
5			1	60	0				5.5
							SP / SM	Sand: orange-brown, very fine to fine, silty, saturated (flowing).	5
							SC / SM	Sand: orange to brown-orange with light gray mottling, very fine to fine, moderately well-sorted, silty, soft clayey laminae throughout saturated; clay partings at 6.9-7' and 7.5-7.8'.	2.7
10							SM / SP	Sand: orange to brown-orange, very fine to fine, moderately well sorted, high silt content, trace clay, soft, saturated; increase in grain size to fine to medium in bottom 1.2' (fining upwards).	-2
							CH	Clay: light gray to brown-gray with horizontal orange banding (FeOx), silty, firm to stiff, medium to high plasticity, moist to wet; with very fine to trace medium sand in pits, 40-50% in upper 0.7' and 50-60% at 13-13.3'.	-3.5
15			2	90	0				-4.5
							SM / ML	Sand: light gray to white, 60-70% very fine to fine PO_4 sand, high silt content, 10-15% oyster shells up to 2.5-3" size, 25- 30% PO_4 pellets, saturated. Sand: as above; sand content 70-80%, 15% PO_4 nodules, 5-10% fine to medium shell hash.	
20									

WELL DIAGRAM



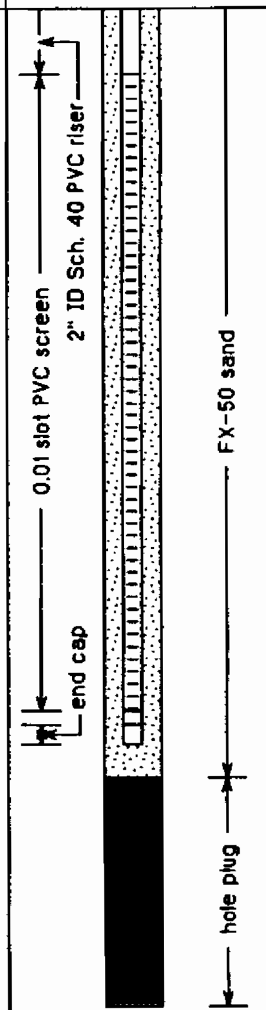
EnSafe/Allen & Hoshall

Monitoring Well NBCE56901D

Project: ZONE E – Naval Base Charleston	Coordinates: 2316803.72 E, 375545.55 N
Location: Charleston, SC	Surface Elevation: 10.5 feet msl
Started at 1055 on 1-21-96	TOC Elevation: 10.25 feet msl
Completed at 1155 on 1-21-96	Depth to Groundwater: 6.16 feet TOC Measured: 3/13/96
Drilling Method: Rotasonic (6.5" OD casing, 3.8" ID coring bit)	Groundwater Elevation: 4.09 feet msl
Drilling Company: Alliance Environmental (SC Cert# 889)	Total Well Depth: 31.0 feet bgs
Geologist: T. Kafka	Well Screen: 21.0 to 30.5 feet bgs

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SM/ML	Sand: olive-brown, 30–40% phosphatic sand in matrix but also present in pits/stringers, fine to coarse shell hash, small PO_4 nodules, soft to firm, very high silt content, low plasticity, wet; sandy stringers at 19.5–20', 20.3–20.5', and 22.4–22.6'.	
25			3	100	0			Sand: as above; phosphatic sand content 60–80% increasing with depth, high silt content, soft to firm, trace to some clay, low plasticity, wet.	-17.8
							SM/GM	Lag deposit: sand and silt matrix with 5% PO_4 nodules (0.5–1 cm), 10% coarse to very coarse oyster shells (up to 1.5 cm), wet.	-19.1
30							ML/CL	Silt: olive-brown, clayey, trace very fine to fine sand, firm to stiff, occasional very fine to fine phosphatic sand pits at 30.6', 30.8', and 31', moist to wet--Ashley Formation.	
35			4	100	0				-24.5
40									

WELL DIAGRAM



Appendix B

COMPARISON OF TOTAL COST OF REMEDIAL SOLUTIONS
Source Control Alternatives

Site: AOCs 569, 570 and 578
Location: CNC, Zone E

Base Year: 2004
Date: October 2003

	Alternative Number 1 **Monitoring/ Natural Attenuation w/ LUCs**	Alternative Number 2 **Enhanced In Situ Anaerobic Biodegradation using Potassium Lactate w/ LUCs**
Total Project Duration (Years)	20	20
Capital Cost	$18,200	$30,000
Annual O&M Cost	$5,500 (Years 1-20)	$57,000 (Years 1-2) $5,500 (Year 3 - 20)
Total Present Worth of Solution	$150,000	$247,000

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 -30 to +50 percent of the actual project costs.

Alternative 1: **Monitoring/Natural Attenuation** **COST ESTIMATE SUMMARY**

Site: Charleston Naval Complex
Description: Monitoring/natural attenuation of the surficial aquifer.

Location: AOCs 569, 570 & 578
Phase: Corrective Measures Study
Base Year: 2004
Date: August 2003

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Monitoring Well Installation	0	EA	$0	$0	No Monitoring Well Installation - Use Existing Network
Monitoring/Natural Attenuation Work Plan					
Groundwater Contingency Plan					
Labor - Project Manager	6	HR	$125	$750	
Labor - Engineer/Hydrogeologist	24	HR	$90	$2,160	
Labor - Editor	8	HR	$65	$520	
Labor - CAD Technician	8	HR	$65	$520	
Monitoring/Natural Attenuation Groundwater Sample Collection Event	1	EA	$5,500	$5,500	Sample 6 Existing Monitoring Wells
SUBTOTAL				**$9,450**	
Land Use Controls	1	EA	$5,000	$5,000	
Project Management	5%	of	$9,450	$473	
Technical Support	5%	of	$9,450	$473	
Construction Management	0%	of	$9,450	$0	
Subcontractor General Requirements	5%	of	$9,450	$473	
SUBTOTAL				**$15,868**	
Contingency	15%	of	$15,868	$2,380	
TOTAL CAPITAL COST				**$18,200**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Groundwater Sample Collection Event	1	EA	$5,500	$5,500	
Land Use Controls	1	EA	$1,100	$1,100	
Annual Report					
Labor - Project Manager	4	HR	$125	$500	
Labor - Engineer/Hydrogeologist	12	HR	$90	$1,080	
Labor - Editor	4	HR	$65	$260	
Labor - CAD Technician	4	HR	$65	$260	
SUBTOTAL				**$8,700**	
TOTAL ANNUAL O&M COST				**$9,000**	

Alternative 1: **Monitoring/Natural Attenuation** **COST ESTIMATE SUMMARY** 2003

Site: Charleston Naval Complex

Description: Monitoring/natural attenuation of the surficial aquifer.

Location: AOCs 569, 570 & 578
Phase: Corrective Measures Study
Base Year: 2004
Date: August 2003

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT WORTH	NOTES
1	FIRST YEAR CAPITAL COST	$18,200	$18,200	$18,200	
1 - 5	ANNUAL O&M COST (Year 1 - 5)	$9,000	$9,000	$131,455	Containment for 20 Years
6 - 20	ANNUAL O&M COST (Year 6 - 20)	$9,000	$9,000		Annual Sampling
				$149,655	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$150,000**	

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 2: **Enhanced In Situ Anaerobic Biodegradation using $C_3H_5KO_3$** **COST ESTIMATE SUMMARY**

Site: Charleston Naval Complex

Description: Potassium lactate injection in the shallow interval of the surficial aquifer.

Location: AOC 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004
Date: October 2003

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Baseline Groundwater Sample Collection Event	1	EA	$6,900	$6,900	Sample 6 Proposed Monitoring Wells
Monitoring Well Installation	1	EA	$5,000	$5,000	three Shallow Wells @ 15 ft Deep
Subtotal				**$11,900**	
Potassium Lactate Injection Materials and Equipment					
Equipment					
Lactate Mix System w/ one Tank	1	LS	$2,000	$2,000	Initial procurement
Generator	1	EA	$500	$500	
Miscellaneous Materials/Supplies	1	LS	$500	$500	Initial procurement
Labor					
Labor - Site Superintendent	16	HR	$40	$640	
Labor - Field Engineer	16	HR	$30	$480	
Labor - Procurement Manager	20	HR	$30	$600	
SUBTOTAL - Injection and Monitoring				$4,720	
SUBTOTAL				**$16,620**	
Land Use Controls	1	ea	$5,000	$5,000	
Project Management	5%	of	$16,620	$831	
Remedial Design	10%	of	$16,620	$1,662	
Construction Management	4%	of	$16,620	$665	
Subcontractor General Requirements	8%	of	$16,620	$1,330	
SUBTOTAL				**$26,107**	
Contingency	15%	of	$26,107	$3,916	
TOTAL CAPITAL COST				**$30,000**	

LS

Alternative 2:	Enhanced In Situ Anaerobic Biodegradation using $C_3H_5KO_3$	COST ESTIMATE SUMMARY	11/13/2003

Site: Charleston Naval Complex

Description: Potassium lactate injection in the shallow interval of the surficial aquifer.

Location: AOC 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004
Date: October 2003

ANNUAL OPERATIONS AND MAINTENANCE COST (YEARS 1 AND 2)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Potassium Lactate Injection					6 Monthly Injections Assume 200 gallons per well per injection event
Potassium Lactate	600	LB	$0.79	$474	
Shipping - Potassium Lactate	1	LS	$200	$200	600 pounds per drum
Injection Subcontractor	6	events	$900	$5,400	3 wells per event
Equipment					
PPE	15	Event	$25	$375	6 Injections per year + 9 monthly sampling events
Decon Equipment/Waste Handling Materials	15	Event	$75	$1,125	
Miscellaneous Materials/Supplies	15	Event	$100	$1,500	
Performance Monitoring					
Post-Injection Sampling	1	LS	$41,400	$41,400	Sample 5 Existing and 6 Proposed Monitoring Wells
SUBTOTAL - Injection and Monitoring				$50,474	
Land Use Controls	1	EA	$1,100	$1,100	
Annual Report					
Labor - Project Manager	6	HR	$125	$750	
Labor - Engineer/Hydrogeologist	12	HR	$90	$1,080	
Labor - Editor	6	HR	$65	$390	
Labor - CAD Technician	4	HR	$65	$260	
SUBTOTAL - Annual Report				**$2,480**	
TOTAL ANNUAL O&M COST				**$54,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT VALUE	NOTES
1	FIRST YEAR CAPITAL COST	$30,000	$30,000	$30,000	
1-3	ANNUAL O&M COST (Year 1 - 3)	$54,000	$54,000	$217,312	Annual Sampling Yrs 1-20 Assume 2 Yr Injection Plan - 12 Injections Per Year Containment for 20 Years LUCs for 20 Years
4-20	ANNUAL O&M COST (Year 4 - 20)	$5,500	$5,500		
				$247,312	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$247,000**	

SOURCE INFORMATION

Element: **Monitoring Well Installation**
Alternatives: **1 and 2**

Site: Charleston Naval Complex
Location: AOCs 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004

Prepared By:
Date:

Checked By:
Date:

WORK STATEMENT

Monitoring well installation to evaluate performance of active remedial alternative.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Shallow Monitoring Well Installation	3	EA	$1,125	$3,375	Assume 15 ft deep @ $75/ft
Equipment Rental	1	WK	$200	$200	MultiRAE
Well Installation Request	1	EA	$500	$500	CH2M-Jones Est.
Transportation and Disposal of Well Cuttings	1	Ton	$75	$75	Assumes Non-Hazardous Waste
SUBTOTAL				**$4,150**	
Project Management	5%	of	$4,150	$208	
Technical Support	5%	of	$4,150	$208	
Construction Management	8%	of	$4,150	$332	
Subcontractor General Requirements	3%	of	$4,150	$125	
SUBTOTAL				**$5,022**	
TOTAL UNIT COST				**$5,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Contingency	20%		$0	$0	
SUBTOTAL				$0	
TOTAL ANNUAL O&M COST				**$0**	

Source of Cost Data

1. Sources are as noted in cost table.
2. Well development included in cost estimate. Assumes non F-listed or non characteristic hazardous waste and acceptance approval to discharge received from the North Charleston POTW.

Element: Land Use Controls
Alternatives: 1 and 2

COST ESTIMATE SUMMARY

Site: Charleston Naval Complex
Location: AOCs 569, 570 ansd 578
Phase: Corrective Measures Study
Base Year: 2004

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
Deed Restrictions - Attorney	4	hour	$200	$800	
Record Deed	4	each	$500	$2,000	
LUC Implementation	24	hours	$75	$1,800	
SUBTOTAL				**$4,600**	
Project Management	10%		$4,600	$460	USEPA 2000, p. 5-13, <$100K
Remedial Design	0%		$0	$0	Not applicable.
Construction Management	0%		$460	$0	Not applicable.
SUBTOTAL				**$460**	
TOTAL CAPITAL COST				**$5,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Evaluation	12	hour	$75	$900	
SUBTOTAL				$900	
Allowance for Misc. Items	20%		$900	$180	
SUBTOTAL				$1,080	
TOTAL ANNUAL O&M COST				**$1,100**	

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).

Element: **Sample Collection and Laboratory Costs**
Alternatives: **1**

Site: Charleston Naval Complex
Location: AOCs 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004

Prepared By:
Date:

Checked By:
Date:

WORK STATEMENT

BASELINE MONITORING
Costs associated with water sample collection, shipment and analysis on a per event and per well basis to evaluate enhanced anaerobic bioremediation performance.
Costs include various indicators during lactate injection period

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor per Event					
Sample Analysis (VOCs - EPA 8260 - Level II)	12	SAMPLE	$110	$1,320	6 Existing Wells, 3 extra QA/QC samples plus 3 new wells for VOCs only
Methane, Ethane, Ethene (MEE)	3	SAMPLE	$150	$450	For 3 injection wells
Alkalinity	3	SAMPLE	$15	$45	For 3 injection wells
Dissolved Iron	3	SAMPLE	$20	$60	For 3 injection wells
Dissolved Manganese	3	SAMPLE	$20	$60	For 3 injection wells
Metabolic Acids	3	SAMPLE	$80	$240	For 3 injection wells
Total Organic Carbon	3	SAMPLE	$25	$75	For 3 injection wells
DHE	3	SAMPLE	$350	$1,050	For 3 injection wells
Sampling Supplies	1	LS	$400	$400	For 3 injection wells
Groundwater Sampling Equipment Rental	1	WK	$1,000	$1,000	Includes MultiRAE, Horiba Meter and Peristaltic Pump
Sample Shipment	1	LS	$200	$200	CH2M-Jones Estimate
Labor - Technicians	32	HR	$55	$1,760	2 hrs/well, 2 people
SUBTOTAL				**$6,660**	
Project Management	2%	of	$6,660	$133	
Technical Support	2%	of	$6,660	$133	
Construction Management	0%	of	$6,660	$0	
Subcontractor General Requirements	0%	of	$6,660	$0	
SUBTOTAL				**$6,926**	
TOTAL UNIT COST				**$6,900**	

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
SUBTOTAL				$0	
TOTAL O&M COST				**$0**	

Source of Cost Data

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

Element: Sample Collection and Laboratory Costs

Alternatives: 1

Site: Charleston Naval Complex	**Prepared By:**	**Checked By:**	
Location: AOCs 569, 570 and 578	**Date:**	**Date:**	
Phase: Corrective Measures Study			
Base Year: 2004			

WORK STATEMENT

BASELINE MONITORING

Costs associated with water sample collection, shipment and analysis on a per event and per well basis to evaluate enhanced anaerobic bioremediation performance.

Costs include various indicators during lactate injection period

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor per Event					
Sample Analysis					3 Existing Wells, 3 extra QA/QC
(VOCs - EPA 8260 - Level II)	36	SAMPLE	$110	$3,960	samples for 6 events
Methane, Ethane, Ethene (MEE)	27	SAMPLE	$150	$4,050	For 3 injection wells for 9 events
Alkalinity	9	SAMPLE	$15	$135	For 3 injection wells for 3 events
Dissolved Iron	9	SAMPLE	$20	$180	For 3 injection wells for 3 events
Dissolved Manganese	9	SAMPLE	$20	$180	For 3 injection wells for 3 events
Metabolic Acids	27	SAMPLE	$80	$2,160	For 3 injection wells for 9 events
Total Organic Carbon	27	SAMPLE	$25	$675	For 3 injection wells for 9 events
DHE	9	SAMPLE	$350	$3,150	For 3 injection wells for 9 events
Sampling Supplies	9	events	$200	$1,800	For 9 events
DO, ORP, pH, Temperature and specific conductance	6	events	$0	$0	Labor and equipment costs included below
Groundwater Sampling Equipment Rental	9	weekly events	$1,000	$9,000	Includes MultiRAE, Horiba Meter and Peristaltic Pump
Sample Shipment	9	LS	$200	$1,800	CH2M-Jones Estimate
Labor - Technicians	108	HR	$55	$5,940	2 hrs/well, 2 people; 3 wells
Labor - Site Superintendent	72	HR	$40	$2,880	
Labor - Field Engineer	72	HR	$30	$2,160	
Labor - Procurement Manager	20	HR	$30	$600	
SUBTOTAL				**$38,670**	
Project Management	3%	of	$38,670	$1,160	
Technical Support	3%	of	$38,670	$1,160	
Construction Management	0%	of	$38,670	$0	
Subcontract Procurement	1%	of	$38,670	$387	
SUBTOTAL				**$41,377**	
TOTAL UNIT COST				**$41,400**	

Source of Cost Data

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

Element: Sample Collection and Laboratory Costs - Monitoring/Natural Attenuation
Alternatives: 1

Site: Charleston Naval Complex
Location: AOCs 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004

Prepared By:
Date:

Checked By:
Date:

WORK STATEMENT

Costs associated with annual sample collection, shipment and analysis for monitoring/natural attenuation alternative. Eight wells included in assessment.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor per Year					
					Various Laboratory Estimates 8 Existing Wells, 3 Extra QA/QC Samples, Includes Data Validation
Sample Analyses					
VOCs (EPA 8260 - Level III)	11	SAMPLE	$132	$1,452	
Alkalinity	9	SAMPLE	$12	$108	
Ferrous Iron	9	SAMPLE	$20	$180	
Methane	9	SAMPLE	$120	$1,080	
DO, ORP, pH, Temperature and specific conductance	1	events	$0	$0	Labor and equipment costs included below
Sampling Supplies	1	EA	$200	$200	
Groundwater Sampling Equipment Rental	1	WK	$1,000	$1,000	Includes MultiRAE, Horiba Meter and Peristaltic Pump
Sample Shipment	1	EA	$200	$200	CH2M-Jones Estimate
Labor - Technicians	18	HR	$55	$990	3 hrs/well, 2 people
SUBTOTAL				**$5,210**	
Project Management	2%	of	$5,210	$104	
Technical Support	2%	of	$5,210	$104	
Construction Management	0%	of	$5,210	$0	
Subcontractor General Requirements	2%	of	$5,210	$104	
SUBTOTAL				**$5,523**	
TOTAL COST -ANNUAL EVENT				**$5,500**	

Source of Cost Data

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

Element: **Present Worth Analysis**

Alternative: **Enhanced In Situ Anaerobic Biodegradation using $C_3H_5KO_3$**

Site: Charleston Naval Complex
Location: AOC 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004

Prepared By:
Date:

Checked By:
Date:

WORK STATEMENT

Calculation of alternative present worth. Assumes total present value earns interest for an entire year (12 months), compound annually.
Discount Rate 3.2%

Present Worth Analysis

Elapsed Time	Year	Discount Factor at 3.2%	Capital Cost	O&M Cost	Total Cost	Total PV Capital Costs at 3.2%	Total PV O&M Costs at 3.2%	Total PV Costs at 3.2%	Balance of Interest Bearing Account at 3.2%
0	2002	1.000	$ 30,000		$ 30,000	$ 30,000	$ -	$ 30,000	$ 224,266
1	2003	0.969		$ 54,000	$ 54,000	$ -	$ 52,326	$ 52,326	$ 170,266
2	2004	0.939		$ 54,000	$ 54,000	$ -	$ 50,703	$ 50,703	$ 116,266
3	2005	0.910		$ 9,000	$ 9,000	$ -	$ 8,188	$ 8,188	$ 107,266
4	2006	0.882		$ 9,000	$ 9,000	$ -	$ 7,935	$ 7,935	$ 98,266
5	2007	0.854		$ 9,000	$ 9,000	$ -	$ 7,689	$ 7,689	$ 89,266
6	2008	0.828		$ 9,000	$ 9,000	$ -	$ 7,450	$ 7,450	$ 80,266
7	2009	0.802		$ 9,000	$ 9,000	$ -	$ 7,219	$ 7,219	$ 71,266
8	2010	0.777		$ 9,000	$ 9,000	$ -	$ 6,995	$ 6,995	$ 62,266
9	2011	0.753		$ 9,000	$ 9,000	$ -	$ 6,778	$ 6,778	$ 53,266
10	2012	0.730		$ 9,000	$ 9,000	$ -	$ 6,568	$ 6,568	$ 44,266
11	2013	0.707		$ 9,000	$ 9,000	$ -	$ 6,365	$ 6,365	$ 35,266
12	2014	0.685		$ 9,000	$ 9,000	$ -	$ 6,167	$ 6,167	$ 26,266
13	2015	0.664		$ 9,000	$ 9,000	$ -	$ 5,976	$ 5,976	$ 17,266
14	2016	0.643		$ 9,000	$ 9,000	$ -	$ 5,791	$ 5,791	$ 8,266
15	2017	0.623		$ 9,000	$ 9,000	$ -	$ 5,611	$ 5,611	$ (734)
16	2018	0.604		$ 9,000	$ 9,000	$ -	$ 5,437	$ 5,437	$ (9,734)
17	2019	0.585		$ 9,000	$ 9,000	$ -	$ 5,269	$ 5,269	$ (18,734)
18	2020	0.567		$ 9,000	$ 9,000	$ -	$ 5,105	$ 5,105	$ (27,734)
19	2021	0.550		$ 9,000	$ 9,000	$ -	$ 4,947	$ 4,947	$ (36,734)
20	2022	0.533		$ 9,000	$ 9,000	$ -	$ 4,793	$ 4,793	$ (45,734)
Total Alternative			$ 30,000	$ 270,000	$ 300,000	$ 30,000	$ 217,312	$ 247,312	

Element:	Present Worth Analysis
Alternative:	Monitoring/Natural Attenuation

Site: Charleston Naval Complex
Location: AOCs 569, 570 and 578
Phase: Corrective Measures Study
Base Year: 2004

Prepared By:
Date:

Checked By:
Date:

WORK STATEMENT

Calculation of alternative present worth. Assumes total present value earns interest for an entire year (12 months), compound annually.

Discount Rate 3.2%

Present Worth Analysis

Elapsed Time	Year	Discount Factor at 3.2%	Capital Cost	O&M Cost	Total Cost	Total PV Capital Costs at 3.2%	Total PV O&M Costs at 3.2%	Total PV Costs at 3.2%	Balance of Interest Bearing Account at 3.2%
0	2002	1.000	$ 18,200		$ 18,200	$ 18,200	$ -	$ 18,200	$ 135,661
1	2003	0.969		$ 9,000	$ 9,000	$ -	$ 8,721	$ 8,721	$ 126,661
2	2004	0.939		$ 9,000	$ 9,000	$ -	$ 8,451	$ 8,451	$ 117,661
3	2005	0.910		$ 9,000	$ 9,000	$ -	$ 8,188	$ 8,188	$ 108,661
4	2006	0.882		$ 9,000	$ 9,000	$ -	$ 7,935	$ 7,935	$ 99,661
5	2007	0.854		$ 9,000	$ 9,000	$ -	$ 7,689	$ 7,689	$ 90,661
6	2008	0.828		$ 9,000	$ 9,000	$ -	$ 7,450	$ 7,450	$ 81,661
7	2009	0.802		$ 9,000	$ 9,000	$ -	$ 7,219	$ 7,219	$ 72,661
8	2010	0.777		$ 9,000	$ 9,000	$ -	$ 6,995	$ 6,995	$ 63,661
9	2011	0.753		$ 9,000	$ 9,000	$ -	$ 6,778	$ 6,778	$ 54,661
10	2012	0.730		$ 9,000	$ 9,000	$ -	$ 6,568	$ 6,568	$ 45,661
11	2013	0.707		$ 9,000	$ 9,000	$ -	$ 6,365	$ 6,365	$ 36,661
12	2014	0.685		$ 9,000	$ 9,000	$ -	$ 6,167	$ 6,167	$ 27,661
13	2015	0.664		$ 9,000	$ 9,000	$ -	$ 5,976	$ 5,976	$ 18,661
14	2016	0.643		$ 9,000	$ 9,000	$ -	$ 5,791	$ 5,791	$ 9,661
15	2017	0.623		$ 9,000	$ 9,000	$ -	$ 5,611	$ 5,611	$ 661
16	2018	0.604		$ 9,000	$ 9,000	$ -	$ 5,437	$ 5,437	$ (8,339)
17	2019	0.585		$ 9,000	$ 9,000	$ -	$ 5,269	$ 5,269	$ (17,339)
18	2020	0.567		$ 9,000	$ 9,000	$ -	$ 5,105	$ 5,105	$ (26,339)
19	2021	0.550		$ 9,000	$ 9,000	$ -	$ 4,947	$ 4,947	$ (35,339)
20	2022	0.533		$ 9,000	$ 9,000	$ -	$ 4,793	$ 4,793	$ (44,339)
Total Alternative			$ 18,200	$ 180,000	$ 198,200	$ 18,200	$ 131,455	$ 149,655	

Appendix C

SCDHEC Specific Comments

1. Section 1

This section should be revised to include a groundwater contour figure for the deeper component of the surficial aquifer.

CH2M-Jones Response:
A groundwater contour figure for the deeper component of the surficial aquifer for this site will be provided in the revised report. The CNC EGIS provides this information as a theme. The groundwater contours in the deeper portion are very similar to those in the shallower portion of the surficial aquifer at this site.

2. Section 3.2.1, Description of Alternative

The statement that "The low concentrations of CVOCs in groundwater indicate that a significant source area with high-level contamination is not present" is an assumption that may be inaccurate. It should be noted that the presence of a source area with high-level contamination, while not likely, is possible. If a source area exists in this area, MNA will most likely prove ineffective. The Tier I team should be made aware that while it is unlikely, the possibility does exist that additional soil investigation/remediation might be necessary in the future. No response necessary.

CH2M-Jones Response:
Comment noted.

3. Section 3.2.2, Key Uncertainties

The Division of Hydrogeology agrees with the listed uncertainties in this section. However, the Division does not concur that the existing monitoring well network is adequate. The TCE contamination in the deeper portion of the aquifer is of specific concern. Monitoring Well E570GW03D has TCE above the MCL, yet there are currently no down-gradient wells being monitored. If existing deep wells are located in areas to fill this data gap, then they should be included in the long-term monitoring program for this site. Otherwise, additional deeps wells should be installed, down-gradient of E570GW03D.

CH2M-Jones Response:
Monitoring well E569GW01D is downgradient of well E570W03D, suitably located, and can be added to the list of wells monitored. VOCs detected in groundwater samples from this well have all been below 10 µg/L; no MCL exceedances have been observed. CH2M-Jones believes that no additional (new) deep wells are needed.

4. Table 3-1, Summary of Chlorinated VOC Concentrations in Select Wells

This table shows that the laboratory detection limit for Vinyl Chloride (VC) is too high. The MCL for VC is 2 µg/L. The detection limit should be below the MCL, otherwise, there is no way to adequately verify that chlorinated solvent degradation is not creating further contamination with the daughter products. All future analyses must be performed with suitable detection and reporting limits.

CH2M-Jones Response:

The analytical method, SW846 8260, that has been used for all VOC analysis for this project since the RCRA Corrective Action program was initiated in 1995 is not capable of achieving a detection limit of 2 µg/L for vinyl chloride. Method 8260 is widely used on RCRA Corrective Action and Superfund projects and the limitation of its detection limit with regard to vinyl chloride's MCL is widely recognized. In spite of this limitation, Method 8260 is considered to be the most suitable overall GC/MS method for VOC analysis. CH2M-Jones does not think it advisable to change the analytical method at this point of the project.

5. Section 4.1, Alternative 1: Monitored Natural Attenuation with Land Use Controls

This section should be revised as necessary to address additional wells, sampling, and analyses congruent with the response to Comment 3 (above).

CH2M-Jones Response:

Sampling for well E569GW01D will be included.

6. Section 4.3, Comparative Evaluation of Corrective Measure Alternatives

Same as Comment 5.

CH2M-Jones Response:

Sampling for well E569GW01D will be included.