Final

Five-Year Review Report

Naval Station Norfolk
Norfolk, Virginia

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic Division

Contract No. N62470-02-D-3052
CTO-152

October 2008

Prepared by

CH2MHILL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Captain David Boone
Commanding Officer
NAVFAC, Mid-Atlantic
9742 Maryland Ave
Norfolk, VA 23511

JUL 29 2009

Re: Second Five-Year Review Report
Naval Station Norfolk
Norfolk, VA

Dear Captain Boone:

Thank you for submitting the report, entitled Five Year Review Report Naval Station Norfolk, Virginia, dated October 2008 to the EPA for review and concurrence. The report was prepared to address the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121 (c) five-year review requirements. EPA has reviewed this five-year review report and compared it to EPA's June 2001 guidance document, *Comprehensive Five Year Review Guidance* (OSWER No. 9355.7-03B-P, EPA 540-R-01-007).

EPA concurs with the Navy's determination that the remedies for the following sites are protective of human health and the environment.

- Site 1 – Camp Allen Landfill
- Site 2 – NM Slag Pile
- Site 3 – Q Area Drum Storage Yard
- Site 6 – CD Landfill
- Site 20 – Building LP 20
- Site 22 – Camp Allen Salvage Yard
- Site 23 – Building LP-20 Plating Shop

Furthermore, as part of this five-year review, EPA has evaluated the Government Performance and Results Act (GPRA) measures for this site and has determined their status is as follows:

Environmental Indicators

Human Health: *Current Exposure Controlled and Protective Remedy in Place*
Groundwater Migration: *Groundwater Migration Under Control*

Sitewide Ready for Anticipated Use

The Site is not Site-Wide Ready for Anticipated Use but is expected to be in 2010. The Site-Wide Ready for Anticipated Use Superfund performance measure requires that all required institutional and other controls required by Record(s) of Decision or other remedy decision document(s) have been put in place, and that the site reach construction completion. Construction Completion at Naval Station is predicted for the summer of 2010.

The requirement for this five-year review at Naval Station Norfolk was triggered by the Remedial Action start date of August 1995 at OU-1, Site 1, Camp Allen Landfill. A previous five-year review report was completed and signed by the Navy on October 3, 2003. The next five-year review will be due five years from the date of this concurrence letter.

If you have any questions, please contact Ben Mykijewycz, Chief of the NPL/BRAC Federal Facilities Branch at 215.814.3351 or Steven Hirsh, remedial Project Manager at 215. 814.3352.

Sincerely,

Kathryn A. Hodgkiss, Acting Director
Hazardous Site Cleanup Division

cc: Tim Reisch
Sharon Baumann

Final

Five-Year Review Report

Naval Station Norfolk
Norfolk, Virginia

Contract Task Order 152

October 2008

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

LANTDIV CLEAN III Program
Contract N62470-02-D-3052

Prepared by

CH2MHILL

Virginia Beach, Virginia

Final

Five-Year Review Report

Naval Station Norfolk
Norfolk, Virginia

October 2008

This report documents the completion of the five-year review for sites 1, 2, 3, 6, 20 22 and 23 at Naval Station Norfolk as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in accordance with CERCLA §121(c), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR).

Approved by:

23OCT08

S. J. DINOBILE
Captain, U.S. Navy
Commanding Officer
Naval Station Norfolk

Date

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name (from CERCLIS): Naval Station Norfolk

EPA ID (from CERCLIS): VA6170061463

Region: 3	**State:** VA	**City/County:** Norfolk

SITE STATUS

NPL Status: ☒ Final ☐ Deleted ☐ Other (specify):

Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete

Multiple OUs? ☒ Yes ☐ No	

Has site been put into reuse? ☐ Yes ☒ No

REVIEW STATUS

Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency: Department of the Navy

Author: Naval Facilities Engineering Command, Mid-Atlantic Division with support from the Navy Installation Restoration Program contractor CH2M HILL

Review period:

Date(s) of site inspection: ***Varies with Installation Restoration Program Site***

Type of review: ☒ Statutory ☐ Policy

☒ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead
☐ Regional Discretion

Review number: ☐ 1 (first) ☒ 2 (second) ☐ 3 (third) ☐ Other (specify):

Triggering action: ☐ Actual RA Onsite Construction ☐ Actual RA Start ☐ Construction Completion ☐ Recommendation of Previous Five-Year Review Report

☒ Other (specify): *Completion of the 2008 Five-Year Review Report*

Triggering action date (from CERCLIS): October 30, 2003

Due date (five years after triggering action date): October 30, 2008

Five-Year Review Summary Form (continued)

1. Site 1, *Camp Allen Landfill*

A. Issues:

- In May of 2004, utility trenching activities were observed in Area A, along the outer security fence at the Brig facility. Additionally, in July 2004, excavation for a drainage ditch in Area A was observed. Both of these activities resulted in a breach of the landfill cover, contamination of the cover with landfill materials, and stockpiling of landfill materials. Navy personnel and regulators were notified and corrective action

was completed October through December 2004. Since these breach activities, the Navy has implemented additional internal review measures for all construction activities to ensure the remedial measures are not violated.

- Vapor intrusion in the Marine Barracks was not evaluated as part of the RI. As limited information is available, additional assessment of the Marine Barracks will be required before the next Five-Year Review Report.

B. Recommendations and Follow-up Actions:

- Continue implementing the facility's site approval procedures. The Navy has revised and implemented an internal review process for all construction activities that occur on the base to ensure the land use controls are not violated. Since the implementation of the revised review, no additional violations have occurred.
- The potential for vapor intrusion within the Marine Barracks will need to be assessed based on the presence of volatile organic compounds (VOCs) within the groundwater before the next Five Year Review.

C. Protectiveness Statement: The remedy at Site 1 consisting of the groundwater extraction system is currently protective of human health and the environment and is expected to be protective in the future. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater extraction system, land use controls (LUCs) (fencing, signage, etc), and the implementation of institutional controls (ICs).

2. Site 2, NM Slag Pile

A. Issues:

- During the May 2005 inspection a hole was observed in the northwestern corner of the asphalt parking lot. To maintain the integrity of the asphalt cover the hole was repaired as documented during the February 2006 inspection.

B. Recommendations and Follow-up Actions:

- Repair holes promptly and conduct inspections to ensure integrity of the cover. The Hole was repaired as documented in the February 2006 inspection.

C. Protectiveness Statement: The cover remedy soil and sediment at Site 2, NM Area Slag Pile, prevents direct contact with soil and sediment. Supporting inspection information and monitoring data indicate the landfill cover is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in unacceptable risks are being controlled through a combination of existence of the cover, LUCs, and the implementation of ICs.

3. Site 3, Q Area Drum Storage Yard

A. Issues:

- There were no issues identified at Site 3 during this five-year review.

B. Recommendations and Follow-up Actions:

- There are no recommendations or follow-up actions identified for the remedy at Site 3.

C. Protectiveness Statement: The remedy at Site 3 consisting of the air sparge/soil vapor extraction (AS/SVE) system is currently protective of human health and the environment and is expected to be protective in the future. The site groundwater concentrations are approaching

the maximum contaminant levels (MCLs) which has resulted in implementation of a closeout strategy. The exposure pathways that could result in unacceptable risks are being controlled through a combination of the groundwater treatment system, LUCs, and the implementation of ICs. Long-term protectiveness of the remedial action will be verified by continuing the long-term monitoring (LTM) program until the clean up levels have been achieved.

4. Site 6, CD Landfill

A. Issues:

- Trees planted within the landfill along Seabee Road impacted the integrity of the landfill.

B. Recommendations and Follow-up Actions:

- The landfill cap was repaired in October 2006. Continue improvement of the facility's site approval process prior to site disturbance is recommended.

C. Protectiveness Statement: The landfill cap remedy at Site 6 prevents direct contact with the soil. Supporting inspection information and monitoring data indicate the landfill cap is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cap, LUCs, and the implementation of ICs.

5. Site 20, Building LP-20 Site:

A. Issues:

- Vapor intrusion was not evaluated as a potential pathway as part of the RI/FS process for the site. Since there are buildings overlying the VOC groundwater plume, further evaluation of the vapor intrusion pathway at Site 20 may be warranted to assess whether this pathway generates potentially unacceptable risk. Since air monitoring was conducted as part of the AS/SVE system pilot study, the results should be assessed to determine if the data is sufficient to evaluate the potential for vapor intrusion at the site.
- There is an overall decrease in the VOC concentrations detected at Site 20; however concentrations remain elevated in samples collected at some of the monitoring wells. Therefore, the RPO team will need to evaluate supplements or alternatives to the current system in order expedite cleanup and further reduce VOC concentrations.

B. Recommendations and Follow-up Actions:

- The potential for vapor intrusion will need to be assessed based on the presence of volatile organic compounds (VOCs) within the groundwater before the next Five Year Review. This assessment should also include an evaluation of the air monitoring results, obtained during the AS/SVE pilot study..
- The RPO team will need to evaluate potential supplements or alternatives to the current system in order expedite cleanup and further reduce VOC concentrations.

C. Protectiveness Statement: The remedy at Site 20 consisting of the existing AS/SVE system is currently protective of human health and the environment and is expected to continue to be protective in the future. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater treatment system, land use controls, and

the implementation of ICs.

6. Site 22, Camp Allen Storage Yard

A. Issues:

- There were no issues identified at Site 22 during this five-year review.

B. Recommendations and Follow-up Actions:

- There are no recommendations or follow-up actions identified for the remedy at Site 22.

C. Protectiveness Statement: The cover systems at Site 22 prevent direct contact with soil and sediment. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers, land use controls (LUCs), and implementation of ICs.

7. Site 23, Building LP-20 Plating Shop

A. Issues:

- There were no issues identified at Site 23 during this five-year review.

B. Recommendations and Follow-up Actions:

- There are no recommendations or follow-up actions identified for the remedy at Site 23.

C. Protectiveness Statement: The cover at Site 23 prevents direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers, land use controls (LUCs), and implementation of ICs.

8. Other Comments:

None

Executive Summary

This Five-Year Review Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Review for Naval Station Norfolk (NSN) in Norfolk, Virginia, was conducted in accordance with the United States (U.S.) Environmental Protection Agency's (USEPA's) Five-Year Review Guidance (USEPA, 2001). The document addresses remedies and remedial actions that resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure, and for which there is a Record of Decision (ROD) or Decision Document (DD) in place. The seven sites incorporated in this review include Site 1—Camp Allen Landfill (CALF), Site 2—NM Slag Pile, Site 3—Q Area Drum Storage Yard (QADSY), Site 6—CD Landfill, Site 20—Building LP-20, Site 22—Camp Allen Salvage Yard, and Site 23—Building LP-20 Plating Shop.

The objective of this Five-Year Review is to evaluate current remedies at these sites and determine whether the remedies are protective of human health and the environment in accordance with the requirements set forth in the ROD or DD. The principal method used to evaluate the protectiveness of the remedies was a review of various reports and documents pertaining to site activities, analytical data, and findings. The methods, findings, and conclusions from the document reviews are presented in this Five-Year Review report. In addition, the this report identifies issues that may prevent a particular remedy from functioning as designed or appropriate, which could endanger the protection of human health and the environment. The overall evaluation of the effectiveness of each remedy is presented as a protectiveness statement developed for each site. The protectiveness statements are provided below.

Site 1—Camp Allen Landfill

The remedy at Site 1 consisting of the groundwater extraction system is currently protective of human health and the environment and is expected to be protective in the future. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater extraction system, land use controls (LUCs) (i.e., fencing, signage, etc), and the implementation of institutional controls (ICs).

Site 2—NM Area Slag Pile

The cover remedy soil and sediment at Site 2, NM Area Slag Pile, prevents direct contact with soil and sediment. Supporting inspection information and monitoring data indicate the landfill cover is in good condition. There have been no changes in the physical conditions of the Site that would affect the protectiveness of the remedy. Exposure pathways that could result in unacceptable risks are being controlled through a combination of existence of the cover, LUCs, and the implementation of ICs.

Site 3—Q Area Drum Storage Yard

The remedy at Site 3 consisting of the air sparge/soil vapor extraction (AS/SVE) system is currently protective of human health and the environment and is expected to be protective in the future. The site groundwater concentrations are approaching the maximum contaminant levels (MCLs) which has resulted in implementation of a closeout strategy. The exposure pathways that could result in unacceptable risks are being controlled through a combination of the groundwater treatment system, land use controls, and the implementation of ICs. Long-term protectiveness of the remedial action will be verified by continuing the long-term monitoring (LTM) program until the cleanup levels have been achieved.

Site 6—CD Landfill

The landfill cap remedy at Site 6 prevents direct contact with the soil. Supporting inspection information and monitoring data indicate the landfill cap is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cap, LUCs, and the implementation of ICs.

Site 20—Building LP-20

The remedy at Site 20 consisting of the existing AS/SVE system is currently protective of human health and the environment and is expected to continue to be protective in the future. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater treatment system, LUCs, and the implementation of ICs.

Site 22—Camp Allen Salvage Yard

The cover systems at Site 22 prevent direct contact with soil and sediment. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers, LUCs, and implementation of ICs.

Site 23—Building LP-20 Plating Shop

The cover at Site 23 prevents direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers, LUCs, and implementation of ICs.

Contents

Appendixes

Tables (Tables are located at the end of each section.)

Figures (Figures are located at the end of each section.)

Acronyms and Abbreviations

AF/VR	aggressive fluid/vapor recovery
amsl	above mean sea level
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AS/SVE	air sparge/soil vapor extraction
Baker	Baker Environmental, Inc.
bgs	below ground surface
CALF	Camp Allen Landfill
CASE	Corrective Action Site Evaluation
CASY	Camp Allen Salvage Yard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	constituents of concern
COPC	constituents of potential concern
CSM	conceptual site model
°F	degrees Fahrenheit
DCA	dichloroethane
DCE	dichloroethene
DD	Decision Document
DDE	dichlorodiphenyldichloroethylene
DNAPL	dense non-aqueous phase liquid
DoD	Department of Defense
DPT	direct push technology
DPVE	Dual Phase Vapor Extraction
EE/CA	Engineering Evaluation/Cost Analysis
EP	Extraction Procedure
ERA	Environmental Risk Assessment
ERM	Effects Range-Median
ESD	Explanation of Significant Difference
ESE	Environmental Science & Engineering, Inc.
ESI	Environmental Site Investigation
FS	Feasibility Study
ft	feet
ft^2	square feet
GMP	Groundwater Management Plan
HHRA	Human Health Risk Assessment

HRS	Hazard Ranking System
IAS	Initial Assessment Study
IC	institutional control
IR	Installation Restoration
IRP	Installation Restoration Program
IRPRI	IRP Remedial Investigation
LANTDIV	Atlantic Division
LTM	long-term monitoring
LUC	land use control
µg/L	micrograms per liter
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MW	monitoring well
NACIP	Navy Assessment and Control of Installation Pollutants
NADEP	Naval Aviation Depot
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NCP	National Contingency Plan
NPL	National Priorities List
NSD	Non-Significant Differences
NSN	Naval Station Norfolk
NTCRA	Non-Time Critical Removal Action
OHM	OHM Remediation Services
OU	Operable Unit
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRAP	Proposed Remedial Action Plan
PWC	Navy Public Works Center
QADSY	Q Area Drum Storage Yard
QAPP	Quality Assurance Project Plan
RA	Risk Assessment
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RBC	Risk-Based Criteria
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFA	RCRA Facility Assessment
RfD	reference dose
RGO	Remedial Goal Objective
RI	Remedial Investigation

RIP	remedy-in-place
ROD	Record of Decision
RPM	Remedial Project Manager
RPO	Remedial Process Optimization
RRR	Relative Risk Ranking
SARA	Superfund Amendments and Reauthorization Act
SC	specific conductivity
SD	sediment
SI	Site Investigation
SMP	Site Management Plan
SVOC	semivolatile organic compound
SW	surface water
SWMU	Solid Waste Management Unit
TBD	To-Be-Considered
TCE	trichloroethene
TCL	target compound list
TOC	total organic carbon
TOX	total organic halides
TPH	total petroleum hydrocarbon
U.S.	United States
UFP	United Federal Policy
USN	United States Navy
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UUUE	unlimited use and unrestricted exposure
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
VDOH	Virginia Department of Health
VDOT	Virginia Department of Transportation
VOC	volatile organic compound
VSWMR	Virginia Solid Waste Management Regulations
WWTP	wastewater treatment plant
yd^2	square yard
yd^3	cubic yard

SECTION 1

Introduction

The Navy conducted this Five-Year Review for Naval Station Norfolk (NSN) in Norfolk, Virginia, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in accordance with CERCLA §121(c), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR). This report has been prepared in accordance with the United States (U.S.) Environmental Protection Agency (USEPA) *Comprehensive Five-Year Review Guidance* (USEPA, June 2001), and summarizes the evaluation of remedies and remedial actions that resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure (UUUE), and for which there is a Record of Decision (ROD) or Decision Document (DD) in place. The NSN sites requiring a Five-Year Review are:

- Site 1—Camp Allen Landfill (CALF)
- Site 2—NM Slag Pile
- Site 3—Q Area Drum Storage Yard (QADSY)
- Site 6—CD Landfill
- Site 20—Building LP-20
- Site 22—Camp Allen Salvage Yard (CASY)
- Site 23—Building LP-20 Plating Shop

The objective of this Five-Year Review is to evaluate current remedies at these seven sites and determine whether the remedies are protective of human health and the environment in accordance with the requirements outlined in the RODs or DDs. The principal method used to evaluate the protectiveness of the remedies was a thorough review of reports, analytical data, and documents pertaining to site activities and findings. The methods, findings, and conclusions from the document reviews are presented in this Five-Year Review. In addition, this report identifies issues that may prevent a particular remedy from functioning as designed or as appropriate, which could endanger the protection of human health and the environment.

This Five-Year Review was prepared pursuant to CERCLA §121 and NCP requirements. A Five-Year Review is required 5 years from the initiation of the first remedial action that leaves hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure. If a site contains multiple remedies, all are subject to a Five-Year Review when at least one remedy is triggered. NSN has elected to follow Navy recommendations of conducting an installation-wide Five-Year Review that includes all sites with remedies in place based on the remedy initiation trigger date for the first site.

This Five-Year Review was prepared pursuant to CERCLA 121 and the NCP. CERCLA 121 states:

> *If the president selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

USEPA interpreted this requirement further in the NCP; 40 CFR 300.430 (f)(4)(ii), which states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The triggering action of this statutory review is the initiation of the selected remedial action for Site 1 (CALF) dated August 1995. The first Five-Year Review for NSN was finalized October 2003 (CH2M HILL, October 2003). This subsequent Five-Year Review is required because hazardous contaminants remain at sites at NSN above levels that allow for unlimited use and unrestricted exposure.

SECTION 2

Facility Background and History

The background information for NSN presented in this section is necessary to identify the potential threats that were posed to the public and the environment at the time of the ROD or DD for each site. This allows for the remedy performance to be compared with the site conditions that the remedies were intended to address. Information presented in this section includes a discussion of the facility description, physical characteristics of the facility, and the environmental history.

2.1 Facility Description

NSN encompasses 4,631 acres in the northwest portion of the City of Norfolk, Virginia (**Figure 2-1**). NSN includes approximately 4,000 buildings, 20 piers, and an airfield. The western portion of NSN is a developed waterfront area containing the piers and facilities for loading, unloading, and servicing naval vessels. Land use in the surrounding area is commercial, industrial, and residential. The waterfront area south of the NSN provides shipping facilities and a network of rail lines for several large industries.

Naval operations began at NSN in 1917 when the U.S. Navy acquired 474 acres of land to develop a naval base to support World War I activities. Bulkheads were built along the coast to extend available land and after extensive dredge and fill operations, 792 acres were under Navy control.

An additional 143 acres were acquired in 1918 and officially commissioned for the Naval Air Station (NAS). From 1936 through 1940, improvements to the piers and expansion of supply and material handling facilities were also completed.

During World War II, major construction projects were completed, including a power plant, numerous runways and hangars, a tank farm, and several barracks/housing complexes. During this time, the area of NSN expanded to more than 2,100 acres. After World War II, NSN continued to acquire land through various types of land transfers and dredge-and-fill operations conducted in areas of Mason Creek, the Bousch Creek Basins, and Willoughby Bay.

NSN has expanded to become the world's largest naval installation, with 105 ships home-ported in Norfolk. The Base currently has 20 piers handling approximately 3,100 ship movements annually. NSN operates in various capacities to provide support to vessels, aircraft, and other activities. Many tenants are housed at NSN, each performing different operations involving the servicing and maintenance of vessels and aircraft.

Ship service and maintenance facilities include utilities hook-up, on-board maintenance, and coordination of ship movements in the harbor. Additional functions include loading, unloading, and handling of fuels and oils used aboard the vessels. Ship and aircraft repair operations consist of paint stripping, patching, parts cleaning, repainting, engine overhauls, and sandblasting processes. NSN's mission is to provide fleet support and readiness for the U.S. Atlantic Fleet.

A number of other military installations are located within a 25-mile radius of NSN—Fort Monroe and Langley Air Force Base to the north, Little Creek Naval Amphibious Base and Fort Story to the east, NAS Oceana to the southeast, Norfolk Naval Shipyard and St. Juliens Creek Annex to the south, and Naval Supply Center-Craney Island Fuel Terminal to the southwest (CH2M HILL, October 1997).

2.2 Physical Characteristics

The major physiographic features of NSN and surrounding area are described in the following subsections.

2.2.1 Climate

The Hampton Roads Area has a maritime climate characterized by long temperate summers and mild winters. The average annual temperature is 60.7 degrees Fahrenheit (°F). July is the warmest month, with temperatures averaging 78.7°F, while January is the coolest, with temperatures averaging 43.1°F. Precipitation averages 43 inches annually and is evenly distributed throughout the year. A slight increase in precipitation occurs from June to August due to the prevalence of convective thunderstorms. The average annual snowfall is 8.8 inches. Winds are generally in an easterly direction and of moderate speed, ranging from 6 to 8 knots (CH2M HILL, October 1997).

2.2.2 Topography

The topography of NSN is nearly level. Surface elevations at the base range from sea level to about 15 feet (ft) above mean sea level (amsl) in the central portion of the base.

2.2.3 Soils

Soils at NSN generally consist of fine sands and silts with a thickness of 20 to 40 ft having low to moderate permeability. Relatively impermeable sediments composed of silt, clay, and sandy clay typically underlie this upper layer of soils. Together, these strata have a combined thickness of approximately 60 ft. The average permeability of soils in Norfolk County is less than 2.5 inches per hour.

The soils at NSN are a complicated distribution of naturally occurring material and dredge-and-fill material. The native soils are composed of unconsolidated fine sands and silts of low to moderate permeability and are generally underlain by relatively impermeable sediments consisting of silt, clay, and sandy clay. The fill material is primarily composed of heterogeneous sediments removed during dredging operations. The composition of the dredge-fill sediments varies from site to site, but it is generally composed of sand, silt, and gravel. Some concrete, stone, and miscellaneous debris were also used as fill material (CH2M HILL, October 1997).

2.2.4 Surface Water Resources

Four major surface water features surround the greater Norfolk area including the James and Elizabeth Rivers, Willoughby Bay, and Chesapeake Bay, all of which are tidal. Most surface water on the base flows either to Mason Creek or to the remnants of Bousch Creek. The northernmost channel of Mason Creek traverses the base and empties into Willoughby

Bay via a subgrade aqueduct. The main channel of Bousch Creek was filled in and replaced by a network of drainage ditches during the base's development. These narrow drainage channels are interspersed throughout the central part of the base. Both Mason Creek and these drainage ditches are tidal throughout the base. Both creeks discharge to Willoughby Bay and ultimately, to the Chesapeake Bay. Some surface water from the base discharges directly into the Elizabeth River (CH2M HILL, October 1997).

2.2.5 Geology and Hydrogeology

NSN is located in the outer Atlantic Coastal Plain Physiographic Province, which is characterized by low elevations and gently sloping relief. The base is underlain by more than 2,000 ft of gently dipping sandy sediments. **Table 2-1** illustrates the stratigraphic hydrogeologic units of southeastern Virginia.

The uppermost geologic unit is the Columbia Group, which is approximately 60 ft thick. The upper 20 to 40 ft consists of unconsolidated fine sands and silts. These sediments possess low to moderate permeabilities and comprise the unconfined Columbia aquifer. The lower 20 to 40 ft consists of relatively impermeable silt, clay, and sandy clay.

The Chesapeake Group underlies the Columbia Group. The uppermost unit in the Chesapeake Group is the Yorktown Formation. It is capped by the Yorktown confining unit, which separates the Columbia aquifer from the underlying Yorktown aquifer. The Yorktown formation is approximately 90 to 100 ft thick in the vicinity of NSN and composed of marine silt and clay and moderately consolidated coarse sand and gravel with abundant shell fragments. The Chesapeake Group is composed of several additional deeper aquifers and confining units.

Two significant shallow aquifer systems in the area are the Columbia aquifer located in the upper 20 to 40 ft of the Columbia Group, and the underlying Yorktown Aquifer. The Columbia aquifer includes the water-table aquifer and consists of discontinuous heterogeneous sand and shell lenses. The water table depth is usually less than 8 ft. The Yorktown Aquifer is semi-confined beneath a clay layer in the upper Yorktown Formation. Water-bearing zones in the Yorktown Aquifer consist of fine to coarse sand, gravel, and shells (CH2M HILL, October 1997).

2.3 Environmental History

Comprehensive environmental restoration activities at NSN began in 1975 under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, termed the Installation Restoration (IR) Program (IRP) in 1986 when changed to reflect the requirements of CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA). The purpose of the NACIP and IRPs was to identify, assess, characterize, and clean up or control contamination from past waste management activities at Navy and Marine Corps facilities.

Given the nature and extent of its operations, the Navy has been involved with toxic and hazardous materials for several decades. The Department of Defense (DoD), as well as general industry, has realized that previously acceptable methods of disposal are no longer sufficient, and actions are being taken, through these programs, to clean up Navy sites that pose a threat to human health or the environment. Current Navy waste management

operations are in compliance with all federal, state, and Navy regulations to ensure safe operation and disposal of hazardous substances.

NSN initiated its environmental investigation efforts by conducting an Initial Assessment Study (IAS) in 1983 (ESE, February 1983) followed by an IRP Remedial Investigation (RI)—Interim Report (IRPRI) (Malcolm Pirnie, May 1988); a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (A.T. Kearney, March 1992); an Aerial Photographic Site Analysis (USEPA, September 1994); Phase I Relative Risk Ranking (RRR) System Data Collection Sampling and Analysis Report (RRR—Phase I) (Baker, January 1996a); and a RRR System Data Collection Sampling and Analysis Report Phase II (RRR—Phase II) (Baker, December 1996e). A total of 170 potential contaminated sites, areas, or solid waste management units (SWMUs) at NSN were identified for evaluation in the IAS, IRPRI, Aerial Site Analysis, RRRs, and other NSN assessments. A detailed discussion of each of these investigations can be found in the most recent Site Management Plan (SMP) (CH2M HILL, April 2008b) and results will be discussed in the following sections as they pertain to each site evaluated during the Five-Year Review.

On June 17, 1996, the USEPA proposed that NSN be added to the National Priorities List (NPL). The USEPA evaluates industrial sites using the Hazard Ranking System (HRS), and those facilities with HRS scores exceeding 28.5 are proposed for the NPL. The HRS score of 50 was assigned by the USEPA to NSN. The proposed listing was followed by a minimum 60-day review and comment period prior to NSN's inclusion on the NPL on April 1, 1997.

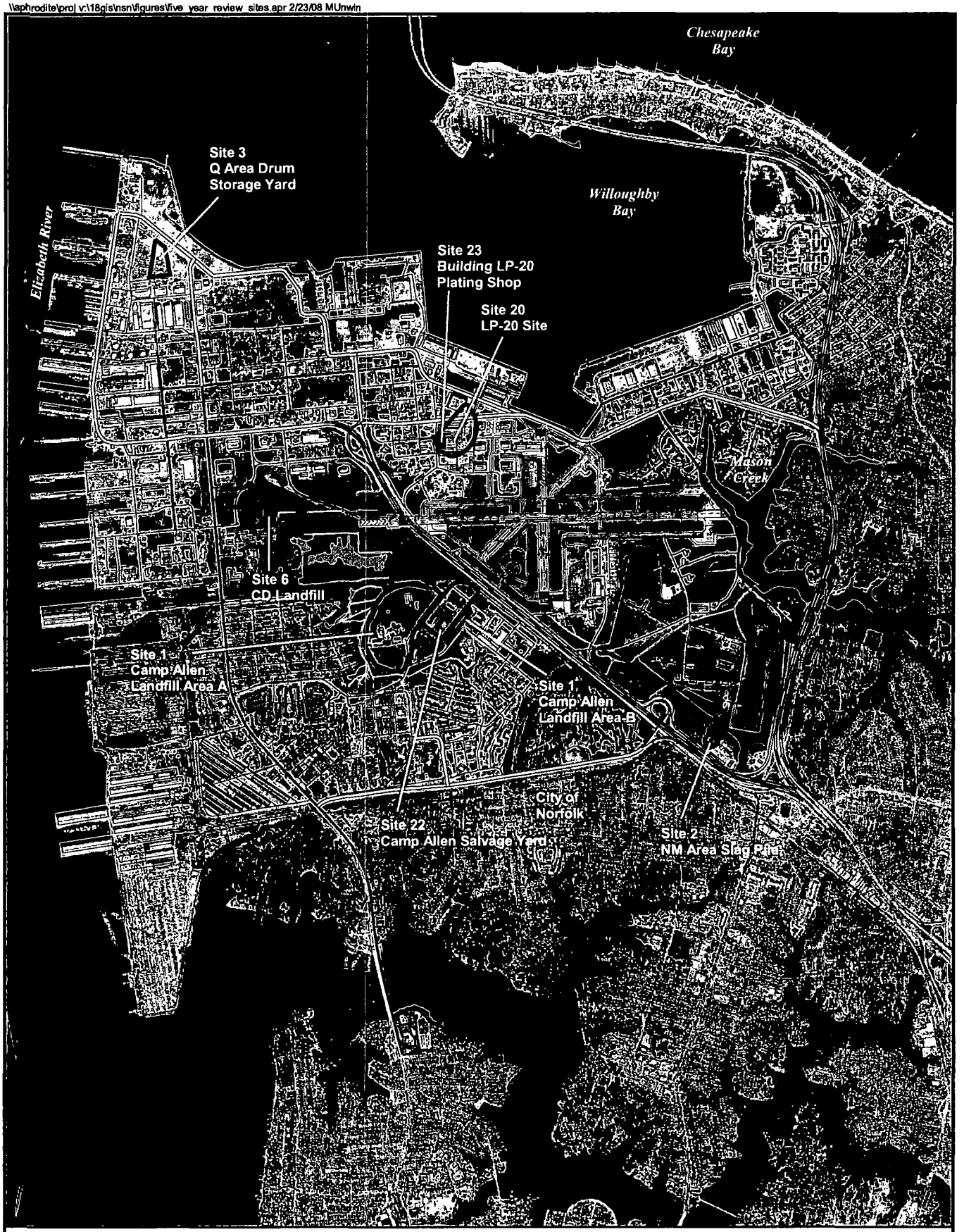
The FFA, negotiated between the Navy, USEPA, and the Virginia Department of Environmental Quality (VDEQ), was finalized in February 1999. In accordance with the FFA, all past and future work at IR sites and SWMUs will be reviewed, and a course of action for future work requirements at each site will be developed. In accordance with the FFA, the Five-Year Review will provide a review and evaluation of the selected remedies for those sites with a CERCLA ROD or DD in place.

Table 2-1
Stratigraphic and Hydrogeologic Units of Southeast Virginia
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

Geologic Age		Group	Stratigraphic Formation	Hydrogeologic Unit
Period	**Epoch**			
Quaternary	Holocene Pleistocene	Columbia	Holocene Deposits Undifferentiated Deposits	Columbia aquifer
Tertiary	Pliocene		Bacons Castle Formation	Yorktown confining unit
		Chesapeake	Yorktown Formation	Yorktown-Eastover aquifer
	Miocene		Eastover Formation	
			St. Mary's Formation	St. Mary's confining unit
			Choptank Formation	St. Mary's Choptank aquifer
			Calvert Formation	Calvert confining unit
	Oligocene	Pamunkey	Old Church Formation	Chickahominy-Piney Point aquifer
	Eocene		Chickahominy Formation	
			Piney Point Formation	
			Nanjemoy Formation	Nanjemoy-Marlboro Clay confining unit
	Paleocene		Marlboro clay	
			Aquia Formation	Aquia aquifer
			Brightseat Formation	Brightseat confining unit
				Brightseat aquifer
Cretaceous	Late Cretaceous		Undifferentiated Sediments	Upper Potomac confining unit
	Early Cretaceous		Potomac Formation	Upper Potomac aquifer
				Middle Potomac confining unit
				Middle Potomac aquifer
				Lower Potomac confining unit
				Lower Potomac aquifer

Source: Harsh and Laczniak, 1990

\\aphrodite\proj v:\18gis\nsn\figures\five_year_review_sites.apr 2/23/08 MUnwin



LEGEND

Land Use Control Area

2003 Aerial Photography

N

0 1700 3400 Feet

Figure 2-1
Installation Map
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 3

Five-Year Review Process

The Five-Year Review process for the sites at NSN is described below. This process includes establishing the review team and the review schedule; notifying and presenting the findings to the community; and a review of all relevant documents.

3.1 Administrative Component

The NSN Five-Year Review team is led by Ms. Winoma Johnson, Remedial Project Manager (RPM) for the IRP at NSN. In addition to Ms. Johnson, the Five-Year Review team consists of the following members:

- Mr. Eric Salopek /RPM for VDEQ
- Mr. Steve Hirsh/RPM for USEPA

The members of the team were notified of the initiation of this Five-Year Review on November 15, 2007 and subsequently, the sites were reviewed from November 2007 to June 2008. The review included the following components:

- Community Involvement
- Document Review
- Data Review
- Site Inspection
- Site Personnel Interviews
- Five-Year Review Report Development and Review

Sections 4 through 10 of this Five-Year Review report describes in detail the review process and findings for each site including the data review, site inspections, and site personnel interviews.

3.2 Community Involvement

Members of the community were notified of the initiation of the Five-Year Review on May 20, 2008 during the NSN Restoration Advisory Board (RAB) meeting. The findings of the review will be presented to the community during the November 2008 NSN RAB meeting and summarized in a community fact sheet that is scheduled to be provided to the public in October of 2008.

3.3 Document Review

This Five-Year Review consisted of a review of relevant documents such as RIs, Feasibility Studies (FSs), Engineering Evaluations/Cost Analyses (EE/CAs), DDs, and RODs as applicable for each site included in this review. These documents are located in the Administrative Record which is available to the public at: Naval Facilities Engineering Command, Atlantic Division, 6506 Hampton Boulevard, Norfolk, VA 23508-1278.

SECTION 4

Site 1—Camp Allen Landfill

4.1 Site 1 Chronology

Below is the chronology of the major site events for Site 1, Camp Allen Landfill.

1940s - 1974	Use of Area A to dispose of municipal, solid, and hazardous wastes
1971	Use of Area B to dispose of wastes from a fire at CASY
1983	CALF identified as a potential source of contamination in the IAS
1988	IRPRI completed
May 1994	Non-time-critical soil removal action implemented in Area B
1994	RI/FS completed
1995	Proposed Remedial Action Plan (PRAP) completed and DD signed
April 1997	NSN placed on NPL
1997	Construction of the groundwater extraction and Dual Phase Vapor Extraction (DPVE) system
1998	Continuous operation of the groundwater extraction and DPVE system begun.
1999	Implementation of annual Long-term Monitoring (LTM)
October 2003	Implementation of Five-Year Review process

4.2 Site 1 Background

Site 1 is located approximately 1 mile east of Hampton Boulevard and 1 mile south of Willoughby Bay (**Figure 2-1**). The site is located within a mixed-use, urban land area, bordered by Bousch Creek on the north, south, and west (Baker, July 1995c). The landfill consists of two primary areas, Area A (45-acre landfill) and Area B (2-acre fire disposal area), as shown in **Figure 4-1**. Residential communities lie to the west of Area A and to the south of both areas. The Camp Allen Elementary School is located south of Area B, and military housing is located south of the elementary school. Currently, the Base brig facility and a heliport are located over a portion of the Area A landfill. Area B is not used at the present time. It is anticipated that a mix of land uses similar to that described will continue in the future.

Areas A and B are covered with soil and vegetation to minimize surface erosion, as they are both adjacent to tidal drainage ditches that convey stormwater runoff to Willoughby Bay. The site groundwater is currently not used for any purpose and potable water used onsite, and by the nearby community, is supplied by the City of Norfolk (Baker, July 1995c). The

shallow aquifer (water table) in the vicinity of the site is not suitable for potable use due to high concentrations of iron, manganese, and suspended solids, as well as a low pH. In addition, City of Norfolk ordinance does not allow potable use of the shallow aquifer. Although the deeper Yorktown Aquifer is generally suitable for potable uses, except near tidal waters where the water can be brackish in quality, this aquifer is not used as a potable source on or in the vicinity of the site (Baker, July 1995c).

The Area A landfill, which operated from the mid-1940s until approximately 1974, was used for the disposal of various waste materials. These materials included demolition debris, sludges from metal plating processes, parts cleaning and paint stripping wastes, overage chemicals, various chlorinated organic solvents, acids, caustics, paints, paint thinners, pesticides, asbestos; and ash from an incinerator, which operated from the mid- 1940s until the mid-1960s. Wastes from a fire at Site 22 (CASY), including drums containing various chemicals, were buried in trenches at Area B in 1971.

The potential for site contamination from disposal practices was initially identified in the 1983 IAS (ESE, February 1983). Field investigations were conducted from 1983 to 1987 to characterize the nature and extent of contamination at the site. In 1988 an Interim RI report (Malcolm Pirnie, May 1988) was completed. Additional groundwater and soil gas samples were collected from 1990 to 1991 and an RI/FS report was completed (Baker, July 1994b).

Contamination from prior disposal practices at Site 1 has affected surface and subsurface soil, sediment, surface water, and groundwater. The primary contaminants found in all media at the site are volatile organic compounds (VOCs). The 1994 RI/FS identified two primary source areas of VOCs north (Area A2) and south (Area A1) of the existing brig facility (Baker, July 1994b). Areas of inorganic contamination of surface water and sediments in the surrounding drainage ditches and in the onsite pond were also detected. Groundwater contamination was detected in both the water table aquifer and the Yorktown Aquifer in Areas A and B. This may be due to the breach of the confining layer between the two aquifers beneath much of the Camp Allen Landfill area. From January 12 through 14, 1993, air sampling was preformed at and around Site 1 to provide analytical support in the assessment of potential health risks from certain VOCs. Samples collected during the investigation followed the procedures in the USEPA Compendium Method TO-14 which is applicable for the determination of a wide variety of VOCs. This method was specifically established for the collection of whole air sampled in SUMMA electropolished, stainless steel containers. This information is summarized in the Final Camp Allen Landfill Remedial Invesigation report, July 1994. Based on results from the air sampling performed at the Brig facility and the Camp Allen Elementary School, no significant site-specific volatile air contaminants were detected.

As part of the RI (Baker, July 1994b), a baseline human health risk assessment and ecological risk assessment (ERA) were conducted. The human health risk assessment evaluated potential risks for both current and future receptors exposed to environmental media at the site. The ecological evaluation focused on three measures of environmental impact from the Camp Allen Landfill: exceedances of state and Federal criteria for surface waters and sediments, the presence and distribution of benthic macroinvertebrates, and a qualitative assessment of terrestrial flora and fauna. Benthic macroinvertebrates were present in every benthic sample and consistent with healthy environments of the same type presented at Camp Allen. The terrestrial environment also appeared to be unaffected by the site

contaminants. Habitats seem to be diverse, wildlife was breeding on site, and natural processes like habitat succession indicated that plants were germinating and competing successfully (Baker, 1994b). The principal threat posed by conditions at Site 1 is the contaminated soil in Area A, which provides a potential source of contamination that threatens the underlying aquifer. Contaminated groundwater at the site could pose a human health risk if utilized as a drinking water source under a potential future residential use scenario.

4.3 Site 1 Remedial Actions

4.3.1 Remedy Selection

A DD (Baker, November 1993) was signed in November 1993 for the non-time critical removal action (NTCRA) of the contaminant source (buried debris and impacted soil) from Area B of the Camp Allen Landfill. This removal action, implemented in May 1994 and completed in January 1995, removed approximately 11,500 tons of soil and debris for disposal offsite.

A PRAP (Baker, March 1995b) and a second DD (Baker, 1995c) identified the risks to the human health and ecological receptors, established the Remedial Action Objectives (RAOs), and defined the selected remedy for Areas A and B. The purpose of the selected remedy was to control the exposure to contamination present in the soil, groundwater, surface water, and sediment. The selected remedy for Site 1 includes *in situ* treatment of soil and shallow groundwater using DPVE in Area A; extraction and treatment of the water table and Yorktown aquifers groundwater in Areas A and B; and LTM and Institutional Controls (ICs) to meet the following RAOs:

- Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment
- Prevent further migration of contaminated groundwater
- Remediate the water table and Yorktown aquifers groundwater for future beneficial use
- Minimize the migration of contaminants from soil and debris in Area A to groundwater and surface water

The DD selected the following objectives for the ICs or Land Use Controls (LUCs) at Site 1:

- Prohibit use of the site for non-residential land use
- Maintain the existing soil cover and fencing
- Prohibit use of the groundwater beneath the site other than for environmental monitoring and testing

These LUCs restrictions have been implemented with the actions detailed in the Remedial Design (RD) for LUCs at Site 1 (CH2M HILL, April 2007b). The LUCs shall be maintained on all land, surface water, sediment, and groundwater within the boundaries of Site 1 until they are no longer required to protect human health or the environment, as stipulated in the DD (Baker, July 1995c).

4.3.2 Remedy Implementation

The established cleanup goals for groundwater are given in **Table 4-1** and the remedial actions are summarized below:

Area A1

- Treatment of the soil and water table aquifer using a DPVE system in combination with ICs that control access to the site and incorporate land and groundwater use restrictions.
- Treatment of the Yorktown aquifer through deep extraction wells that pump the groundwater to an onsite treatment system where solids are removed via clarification/ filtration to prevent fouling of the treatment system.

Area A2

- A pilot study in this area showed that DPVE was an ineffective treatment due to the lack of identifiable contaminants observed in the extracted groundwater or soil vapors and the low hydraulic conductivity of the soil matrix. Therefore, ICs were implemented and the shallow groundwater in this area is extracted through conventional pumping for treatment by the onsite system.
- Implementation of ICs for the Yorktown aquifer as the plume is not expected to migrate offsite.

Area B

- Treatment of soil via hotspot removal and offsite disposal of the contaminated soil and debris.
- Extraction and treatment of both the shallow and deep aquifer and implementation of ICs.

Construction of the groundwater extraction and treatment system was initiated in 1997 and continuous operation of the Camp Allen Treatment Plant began in November 1998. **Figures 4-1 and 4-2** illustrate the layout of the system with associated shallow and deep monitoring well locations. Groundwater samples were collected from monitoring wells in March 1997 and June 1998 to provide baseline information on water quality before the extraction system was started. In August 1997, the extraction wells were sampled to provide information on water quality prior to system startup. In May 1998, the DPVE system was completed and began operation.

In accordance with the DD, Site 1 is part of the LTM program at NSN. The LTM plan for the Site 1 groundwater remediation system requires sampling of monitoring wells and surface water locations until cleanup goals are met or until the concentrations of the contaminants of concern reach asymptotic levels. An ERA through Step 7 for the Upper Reaches of Bousch Creek as related to Site 1 was completed in 2006 (CH2M HILL, November 2006a). It concluded unacceptable risk to benthic invertebrate receptors in the Upper Reaches of the creek from exposure to metals. The NSN Partnering Team agreed to mitigate the risk in approximately 2,1000 linear feet of the creek in the vicinity of Site 1 using a sediment removal strategy. The selected NTCRA concluded in April 2008 and consisted of the excavation of 2 ft of sediment throughout the designated removal areas and backfill of 1 ft clean fill. Following the removal, upland disturbed areas were seeded and erosion and

sediment controls will remain until the vegetation is established (Agviq/CH2M HILL. September 2008b).

4.3.3 System Operation/Operation and Maintenance

The standard operation and maintenance (O&M) of the DPVE and groundwater extraction treatment systems is documented in the *Operations and Maintenance Manual for Soil and Groundwater Remedial Action* (OHM, August 1997). The operation of the groundwater extraction system was modified to include precipitation of dissolved inorganic constituents in the groundwater to prevent fouling of the system.

The majority of the process optimization measures at Site 1 consist of equipment and process modifications to the treatment plant to reduce maintenance costs and increase the efficiency of operation. Current optimization efforts include undergoing accelerated remediation by aggressive fluid/vapor recovery (AF/VR) at hotspot area at B-20W. Additionally, shallow groundwater delineation activities near B-MW3A and B-MW11A are ongoing to determine if vinyl chloride is prevalent in the vicinity of these two wells and if it is feasible to consider localized groundwater treatment alternatives over continued operation of the shallow treatment system in this vicinity.

4.4 Site 1 Progress Since the Last Review

The LTM activities have continued at Site 1 in accordance with the *Long Term Monitoring Plan for Four Sites* (CH2M HILL, May 2007e). The LTM activities consists of annual sampling of up to 50 monitoring well and five stream locations for the Target Compound List (TCL) VOCs and the collection of water level measurements semiannually to determine groundwater flow at Site 1. The results of the monitoring are summarized in Section 4.5.1 of this report and documented in greater detail in the *Draft 2007 Annual Long Term Monitoring Report for Four Sites* (CH2M HILL, December 2007f) (hereafter referred to as the 2007 LTM Report). Additionally, site inspections at the landfill are performed quarterly. Results of the most recent site inspection are summarized in Section 4.5.2 of this report.

The groundwater beneath both Sites 1 and 22 is considered to be one hydrogeologic unit by the NSN Partnering Team (February 2005). As a result of this determination, the NSN Partnering Team has evaluated the current groundwater treatment system to determine if it remains protective for the constituents at Site 22. This evaluation recommended the collection of an additional round of total and dissolved arsenic samples from select shallow monitoring wells to support the RI conclusion that there is not a discernable dissolved arsenic plume at Site 1.

The shallow aquifer cleanup goals detailed in the DD were risk-based values for non-potable use as the site is restricted to industrial use only and therefore, the groundwater is not to be used as a potential drinking source. However in November 2007, the NSN Tier I Partnering Team came to an agreement to revise the groundwater cleanup goals from the risk-based values to MCLs for VOCs in the shallow aquifer. The deeper aquifer cleanup goals detailed in the DD were set at the MCLs (**Table 4-1**). A Non- Significant Differences (NSD) document is currently being prepared to detail this DD cleanup goal revision.

4.5 Site 1 Five-Year Review Process

4.5.1 Long-term Monitoring Data Review

Groundwater Monitoring

The baseline groundwater quality data for Site 1 were collected in March 1997 (Baker, 1997) and in June 1998 (CH2M HILL, September 1998b). The extraction system began operation in July 1997, and was shut down for adjustments in March 1998. The system was restarted in November 1998 and has been in operation since. The results of the baseline monitoring and data collected during the initial operation of the extraction system were evaluated in the *Camp Allen Landfill Long Term Monitoring Plan* (CH2M HILL, September 1998b).

The latest round of LTM groundwater sampling at Site 1 was performed in March 2007 (Round 9). These results are presented in the 2007 LTM Report. **Figures 4-3** and **4-4** provide a comparison of the baseline analytical data collected in 1997-1998 and the most recent LTM analytical data collected in 2007. Overall, the analytical results indicate that VOC concentrations at Areas A and B of the CALF have decreased since startup of the treatment system.

Concentrations of constituents identified as contaminants of concern (COCs) at Site 1 are presented in **Figures 4-3** and **4-4**. The concentrations of these COCs in the shallow aquifer of in both Areas A and B have generally decreased or remained the same. However, there are four areas that are being evaluated by the Remedial Process Optimization (RPO) Team for supplemental remedial options. These areas are B-20W, A2-MW29, B-MW15A and B-MW35A, and B-MW11A and B-MW3A. In Area A, the total VOC concentrations in monitoring well B-20W have increased since first sampled in 1992 during a remedial investigation. Currently, B-20W is undergoing accelerated remediation by AF/VR. Additionally, the Remedial Process Optimization (RPO) Team is evaluating additional options for this area, as well as the hot spot areas (B-MW15A and B-MW35A, and B-MW11A and B-MW3A). In Area B, the hot spot in the vicinity of B-MW11A and B-MW3A is undergoing an evaluation of remedial options in order to accelerate the VOC removal. This was implemented in early 2008 with a delineation activity to further define the extent of the hot spot. The RPO team is also evaluating additional options for the remaining hot spot areas.

The majority of the COCs concentrations in the deep monitoring wells in Areas A and B have shown a decrease since the baseline concentrations. There are two areas (B-MW1B and B-MW3B) where there were similar or slightly higher VOC concentrations. However, the groundwater extraction system has captured the shallow and deep groundwater which has prevented groundwater from migrating toward the residential areas.

Surface Water Monitoring

Surface water sampling began in 2000 as part of the LTM. The latest round of LTM groundwater sampling at Site 1 was performed in March 2007. **Figure 4-5** provides a comparison of the analytical data collected from the first round of sampling at each surface water sampling location and the most recent analytical data collected in 2007. Three surface water sampling locations to the north of the site all show a decreasing trend in the VOC concentrations since the first round of sampling. The two sampling locations to the south of

the site had no VOCs detected during the first round of sampling but reported methyl-tert-butyl ether in 2007. In general, the VOC concentrations in the surface water are orders of magnitude lower than those detected in the groundwater.

4.5.2 Site Inspections

Site inspections have been conducted quarterly at Site 1 to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review.

Since the previous Five-Year Review, the inspections noted two issues that were promptly resolved. In May of 2004, utility trenching activities were observed in Area A, along the outer security fence at the Brig facility. Additionally, in July 2004, excavation for a drainage ditch in Area A was observed. Both of these activities resulted in a breach of the landfill cover, contamination of the cover with landfill materials, and stockpiling of landfill materials. Navy personnel and regulators were notified and corrective action was completed between October and December 2004. Since these breach activities, the Navy has implemented additional internal review measures for all construction activities to ensure the remedial measures are not violated. Following the May and July 2004 excavation activities, only minor corrective measures, including monitoring well repairs, bollard replacement, fence repairs, and vegetation maintenance have been necessary. The most recent inspection was conducted in February 2008 and no discrepancies were noted. Photographs taken during the February 2008 site inspections are included in **Appendix A**.

4.5.3 Site Interviews

The O&M contractor for the landfill was interviewed on May 1, 2008. The contractor provides full time coverage of the treatment system at CALF. Their role includes system operation, maintenance, and trouble shooting. No significant issues were identified during the interview. Details of the Site 1 interview are provided in **Appendix B**.

4.6 Site 1 Technical Assessment

Is the remedy functioning as intended by the DDs?

Based on the review of the documents, monitoring results, applicable or relevant and appropriate requirements (ARARs), risk assumptions and results of the inspections, the remedy is functioning as intended by the DD.

A review of the analytical data indicates that the remediation system at Site 1 is preventing off-site migration of VOCs to the residential areas and removing VOC mass from the deep and shallow aquifers. The effective implementation of ICs has prevented exposure to, or ingestion of, contaminated groundwater, subsurface soil, debris, surface water, and sediment.

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of selection still valid?

Changes in Standards and To Be Considereds (TBCs). No substantial changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-

Year Review. The NSN Partnering Team agreed to revise the shallow aquifer groundwater cleanup goals at the Site that were detailed in the DD to the MCL (**Table 4-1**). The change in the groundwater cleanup goals for Site 1 will be documented in a NSD to the DD. The change does not adversely affect the protectiveness of the remedy and is discussed in greater detail below.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified and there is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 1, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment (RA) or the classes of constituents identified as COCs. Additionally, the Yorktown aquifer cleanup goals are based on MCLs and the shallow aquifer groundwater cleanup goals are being revised to MCLs, and therefore changes in toxicity values would not change the cleanup goals for the groundwater.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how human health risk assessments (HHRAs) are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 1. Based on the results of the HHRA and review of more recent data, the LUCs need to remain in place as the remediation goals have not yet been met. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

Indoor air samples collected from the Brig and the Camp Allen Elementary School in January 1993 were evaluated in the *Baseline Risk Assessment, Camp Allen Landfill* (Baker, 1995a). The data indicated that there were no unacceptable risks associated with inhalation of indoor air in either of these buildings to current building occupants (industrial workers and prisoners in the Brig and students and teachers in the school). Additional indoor air samples have not been collected from these buildings since the completion of the RA. Therefore, the concentration trends in the shallow aquifer groundwater were reviewed. As the concentrations are generally decreasing in the shallow groundwater, it is believed that the contribution of vapors from groundwater into these buildings would also be decreasing, thus the previous risk assessment evaluation is still considered to be valid and there are no unacceptable risks with the inhalation of indoor air in either of these buildings. While an indoor air assessment was not completed for the barracks, the approach for the elementary school indoor air assessment is consistent with the approach that would have been applied to evaluate indoor air in the barracks. Since the concentrations in the vicinity of the barracks from the long term monitoring report are either lower or similar to those in wells near the school, it is assumed that there would also not be a risk associated with the indoor air within the barracks with the assumption that the building construction is similar. Additionally, based on additional delineation via DPT sampling in 2008 the outer edge of the COC groundwater plume does not appear to be within 100 feet of the barracks, as there were no VOC detections in samples located nearest the barracks. Therefore, vapor intrusion

does not appear to be a pathway of concern for occupants of the barracks (USEPA, November 2002). However, as limited data is available for the barracks, additional assessment will be required before the next Five Year Review.

As discussed in the 2007 LTM Report, overall, the analytical results indicate that VOC concentrations at Areas A and B of the CALF have decreased since startup of the treatment system; therefore, the remedy is still considered to be protective for human health.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

4.7 Site 1 Issues Identified

Table 4-2 presents the issues that have been identified for Site 1 based on this Five-Year Review.

TABLE 4-2
Issues for Site 1
Naval Station Norfolk

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Vapor intrusion in the Marine Barracks was not evaluated as part of the RI. Because limited information is available, additional assessment of the Marine Barracks will be required before the next Five-Year Report.	N	N
In May of 2004, utility trenching activities were observed in Area A, along the outer security fence at the Brig facility. Additionally, in July 2004, excavation for a drainage ditch in Area A was observed. Both of these activities resulted in a breach of the landfill cover, contamination of the cover with landfill materials, and stockpiling of landfill materials. Navy personnel and regulators were notified and corrective action was completed October through December 2004. Since these breach activities, the Navy has implemented additional internal review measures for all construction activities to ensure the remedial measures are not violated.	N	N

4.8 Site 1 Recommendations and Follow-up Actions

Table 4-3 presents recommendations and follow-up actions for Site 1.

TABLE 4-3
Recommendations and Follow-up Actions for Site 1
Naval Station Norfolk

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date	Affects Protectiveness (Y/N)	
				Current	Future
Vapor intrusion in the Marine Barracks was not evaluated as part of the RI. Because limited information is available, additional assessment of the Marine Barracks will be required before the next Five-Year Report.	The potential for vapor intrusion within the Marine Barracks will need to be assessed based on the presence of the VOC within groundwater.	Navy EPA VDEQ	Sept. 2008	N	N
In May of 2004, utility trenching activities were observed in Area A, along the outer security fence at the Brig facility. Additionally, in July 2004, excavation for a drainage ditch in Area A was observed. Both of these activities resulted in a breach of the landfill cover, contamination of the cover with landfill materials, and stockpiling of landfill materials. Navy personnel and regulators representatives were notified and corrective action was completed October through December 2004.	The Navy has revised and implemented an internal review process for all construction activities that occur on the base to ensure the land use controls are not violated. Since the implementation of the revised review, no additional violations have occurred.	Navy EPA VDEQ	Summer 2004	N	N

4.9 Site 1 Protectiveness Statement

The remedy at Site 1 consisting of the groundwater extraction system is currently protective of human health and the environment and is expected to be protective in the future. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater extraction system, LUCs (i.e., fencing, signage, etc), and the implementation of ICs.

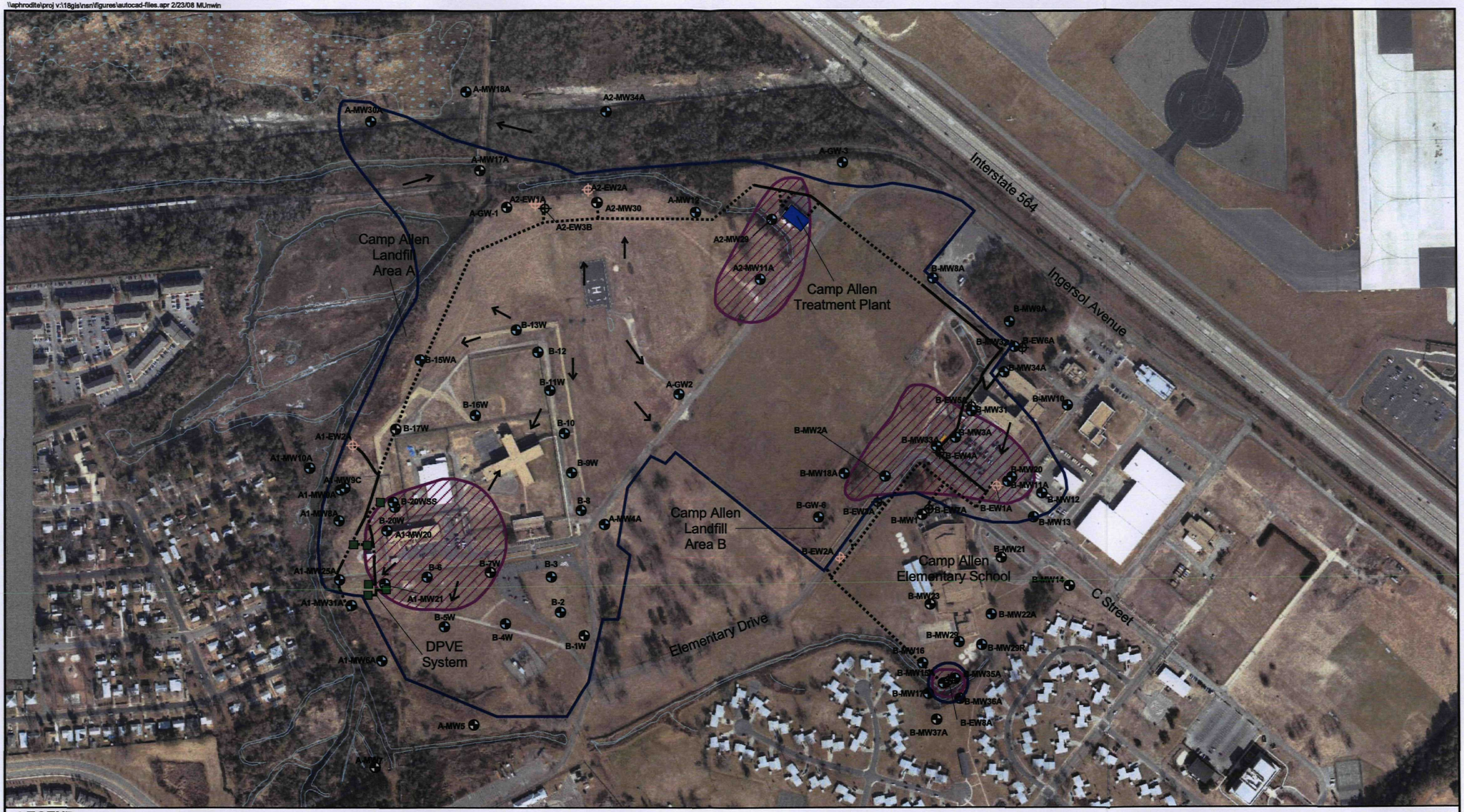
Table 4-1
Cleanup Goals for Groundwater at Site 1
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

Contaminant of Concern	Deep Aquifer Cleanup Goals (µg/L) MCL	Shallow Aquifer Original Cleanup Goals (µg/L) Risk-based	Shallow Aquifer Revised Cleanup Goals (µg/L)[a] MCL
1,2-Dichloroethane	5	190	5
cis-1,2-Dichloroethene	70	15,000	70
1,1,1-Trichloroethane	200	13,500	200
Benzene	5	600	5
Ethylbenzene	700	150,000	700
Tetrachloroethene	5	340	5
Toluene	1,000	301,000	1,000
Trichloroethene	5	1,600	5
Vinyl Chloride	2	9	2
Xylenes	10,000	3,000,000	10,000

Notes:

[a] In November 2007, the NSN Tier 1 Partnering Team agreed to revise the groundwater cleanup goals from the risk-based values to MCLs for the shallow aquifer pending the approval of a Non-Significant Difference.

\\aphrodite\proj v:\18gis\nsn\figures\autocad-files.apr 2/23/08 MUnwin



LEGEND

- Shallow Monitoring Well
- Shallow Monitoring Well not included in LTM
- Shallow Extraction Well
- Inactive Shallow Extraction Well
- DPVE Well
- Shallow Aquifer Groundwater Plume
- Land Use Control Area
- Piping for Groundwater Treatment System
- Piping for Groundwater Treatment System (Assumed Location)
- Direction of Groundwater Flow (May 2007)
- February 2005 Aerial Photography

N

0 400 800 Feet

Figure 4-1
Site 1 - Shallow Aquifer Treatment System,
Monitoring Well Network and Groundwater Plume
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\autocad-files.apr 2/24/08 MUnwin

LEGEND

- Deep Monitoring Well
- Deep Monitoring Well not included in LTM
- Deep Extraction Well
- Inactive Deep Extraction Well
- Deep Aquifer Groundwater Plume
- Land Use Control Area
- Piping for Groundwater Treatment System
- Piping for Groundwater Treatment System (Assumed Location)
- Direction of Groundwater Flow (May 2007)
- February 2005 Aerial Photography

N

0 400 800 Feet

Figure 4-2
Site 1 - Deep Aquifer Treatment System,
Monitoring Well Network and Groundwater Plume
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\fiveyearreview\figure4-3_site1_voc_shallow.apr 8/22/08 MUnwin

B-MW2A	Mar-97	Mar-07
1,1,1-Trichloroethane	ND	22
1,1-DCA	ND	6.9 J
1,1-DCE	ND	2.9 J
1,2-DCA	4 J	12 J
1,4-Dichlorobenzene	NA	4.9
Benzene	ND	5.3 J
Chlorobenzene	8 J	5.5 J
PCE	ND	0.54 J
TCE	ND	120
Freon-11	NA	100
VC	ND	2.9 J
cis-1,2-DCE	NA	130

A-MW30A	Apr-00	Mar-07
1,2-DCA	ND	0.48 J
Chloroform	1.4	ND

A2-MW34A	Apr-00	Mar-07
Acetone	29	ND
Chloroform	1.1	ND

A2-MW29	Jun-98	Mar-07
1,1-DCA	0.6 J	ND
1,1-DCE	1	0.43 J
Chlorobenzene	0.7 J	ND
TCE	ND	1.9
VC	5.1	23
cis-1,2-DCE	0.7 J	43
trans-1,2-DCE	15	11

A-GW-3	Mar-01	Mar-04
Toluene	0.2 J	ND

A2-MW11A	Mar-97	Mar-07
1,1-DCA	ND	0.39 J
1,1-DCE	ND	1.3
1,2-DCE (total)	180	NA
Chlorobenzene	ND	1.4
PCE	2 J	ND
TCE	28	10
VC	23 J	11
cis-1,2-DCE	NA	53
trans-1,2-DCE	NA	1.9

B-MW32	Mar-00	Mar-01
Chloroform	1.1	ND
Toluene	ND	0.3 J

B-MW34A	Mar-01	Mar-07
Toluene	0.9 J	ND

A1-MW9A	Mar-97	Mar-07
VC	ND	0.77
cis-1,2-DCE	NA	2.7
trans-1,2-DCE	NA	0.63

A1-MW10A	Mar-02	Mar-07
MTBE	0.2 J	0.34 J
TCE	0.24 J	ND
VC	0.84 J	ND
cis-1,2-DCE	5.6	0.34 J

A1-MW8A	Mar-97	Mar-07
VC	2 J	ND

B-MW31	Mar-00	Mar-01
2-Hexanone	ND	2 J
Benzene	ND	0.7 J
Carbon disulfide	ND	0.7 J
Toluene	ND	1
VC	ND	0.5 J
cis-1,2-DCE	ND	0.2 J
trans-1,2-DCE	ND	0.2 J

B-MW3A	Mar-97	Mar-07
1,1,1-Trichloroethane	44	ND
1,1-DCA	160	0.89
1,1-DCE	89	0.32 J
1,2-Dichlorobenzene	NA	0.75
1,2-DCA	170	ND
1,2-DCE (total)	1,000	NA
Benzene	330	1
Chlorobenzene	3 J	ND
PCE	13	ND
TCE	850	6.1
Freon-11	NA	0.68
VC	190	17
cis-1,2-DCE	NA	16

B-MW33A	Apr-00	Mar-07
1,1,1-Trichloroethane	55	0.73
1,1,2-Trichloroethane	1.3	ND
1,1-DCA	31	3.9
1,1-DCE	28	0.69
1,2-Dichlorobenzene	2.5	7.8
1,2-DCA	100	0.88
1,4-Dichlorobenzene	4.4	1.8
Benzene	43	11
Chlorobenzene	ND	14
Chloroform	2.6	ND
Cyclohexane	ND	0.63
Ethylbenzene	ND	9.8
Isopropylbenzene	ND	0.74
Methylcyclohexane	ND	1.1
Styrene	ND	0.57
PCE	4.7	7.3
Toluene	ND	16
TCE	680	8.7
Freon-11	NA	41
VC	4.2	160
Xylene, total	ND	25
cis-1,2-DCE	230	170
trans-1,2-DCE	0.8 J	1.6

B-20W	Mar-97	Mar-07
1,1,2-Trichloroethane	ND	6.7 J
1,1-DCA	ND	5.8 J
1,1-DCE	ND	6.9 J
1,2-DCA	ND	86 J
1,2-Dichloropropane	ND	1.6 J
2-Butanone	ND	76 J
2-Hexanone	ND	5.2 J
4-Methyl-2-pentanone	ND	3,600 J
Acetone	ND	170 J
Benzene	ND	410
Chloroform	ND	15 J
Cyclohexane	NA	22 J
Ethylbenzene	ND	21 J
Isopropylbenzene	NA	8.3 J
Methyl acetate	NA	31 J
Methylcyclohexane	NA	32 J
Toluene	ND	11,000
TCE	ND	1.4 J
VC	ND	24,000
Xylene, total	ND	270 J
cis-1,2-DCE	NA	22,000
trans-1,2-DCE	NA	25 J

B-MW29R	Feb-02	Mar-05
Toluene	0.19 J	ND
cis-1,2-DCE	ND	0.19 J

B-MW29	Jun-98	Mar-00
1,2-Dichloropropane	3.5	ND
TCE	1.1	ND
VC	1.9	ND

B-MW36A	Feb-02	Mar-04
MTBE	ND	0.31 J

B-MW35A	Feb-02	Mar-07
1,1-DCA	1 J	1.3
1,1-DCE	9 J	2.2
1,2-DCA	32	8.1
Benzene	1.9 J	1.6
Cyclohexane	NA	2 J
TCE	100	22
VC	160	370
cis-1,2-DCE	110	51
trans-1,2-DCE	3.3 J	1.6

B-MW11A	Mar-97	Mar-07
1,1-DCA	18	ND
1,1-DCE	11	ND
1,2-Dichlorobenzene	NA	0.5
1,2-DCA	50	0.92
1,2-DCE (total)	3,900	NA
Benzene	69	0.7 J
Chlorobenzene	9 J	ND
Toluene	12	ND
TCE	63	3.8 J
VC	2,700	38
Xylene, total	3 J	ND
cis-1,2-DCE	NA	35

A1-MW21	Mar-97	Mar-07
1,2-Dichlorobenzene	NA	0.49 J
1,2-DCE (total)	3 J	NA
Benzene	10 J	1
Chlorobenzene	3 J	2.8
Cyclohexane	NA	5.1
Isopropylbenzene	NA	42
Methylcyclohexane	NA	10
VC	4 J	ND
Xylene, total	ND	1.1

B-MW16	Mar-97	Mar-02
1,1-DCE	4 J	ND
1,2-DCA	30	ND
1,2-DCE (total)	30	NA
Benzene	6 J	ND
TCE	8 J	ND
VC	250	0.24 J
cis-1,2-DCE	NA	0.18 J

B-MW17	Mar-01	Mar-03
TCE	ND	0.066 J

B-MW15A	Mar-97	Mar-07
1,1-DCE	28	ND
1,2-DCA	70	2.4 J
1,2-DCE (total)	160	NA
Benzene	9 J	1.4 J
Cyclohexane	NA	1.8 J
Methylcyclohexane	NA	0.75 J
Toluene	ND	0.32 J
TCE	93	ND
VC	450	190
cis-1,2-DCE	NA	2.6 J
trans-1,2-DCE	NA	3.6 J

VOCs	MCLs (µg/L)
1,1,1-Trichloroethane	200
1,2-Dichloroethane (1,2-DCA)	5
Benzene	5
Ethylbenzene	700
Tetrachloroethene (PCE)	5
Toluene	1,000
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2
Xylene, total	10,000
cis-1,2-Dichloroethene (cis-1,2-DCE)	70

Camp Allen Landfill Area A

Camp Allen Landfill Area B

Interstate 564

Ingersol Avenue

Elementary Drive

Street

LEGEND

- Shallow Monitoring Well
- Shallow Monitoring Well not included in LTM
- Active Extraction Well
- Inactive Extraction Well
- Land Use Control Area
- Shallow Aquifer Groundwater Plume

← Direction of Groundwater Flow (May 2007)

February 2005 Aerial Photography

NA - Not analyzed

ND - Not detected

J - Reported value is estimated

MTBE - Methyl-tert-butyl ether

VOC - Volatile organic compounds

Notes: Units are in micrograms per liter (µg/L).
The detected concentration values that exceed MCL values are highlighted.
This figure only shows the detected VOCs from the first and last rounds of sampling at each sampling location.
*1992 Remedial Investigation was used for comparison because there is uncertainty associated with the 1997 baseline data.

N

0 500 1000 Feet

Figure 4-3
Site 1 - VOCs in Shallow Monitoring Wells
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\fiveyearreview\figure4-4_site1_voc_deep.apr 8/21/08 MUnwin

A-MW17B	Mar-97	Jun-98	Mar-07
1,1-DCE	ND	2.2	ND
1,2-DCA	11	NA	4
1,2-DCE (total)	80	NA	NA
Benzene	ND	1.7	ND
TCE	7 J	12	3.6
VC	ND	20	0.37 J
cis-1,2-DCE	NA	ND	15
trans-1,2-DCE	NA	54	ND

A-MW30B	Jun-98	Mar-07
1,1-DCE	5.8	ND
1,2-DCA	NA	0.33 J
1,2-Dichloropropane	5.1 J	ND
Benzene	1.3	0.62
TCE	22	0.56
VC	19	1.7
cis-1,2-DCE	ND	14
trans-1,2-DCE	99	ND

A-MW18B	Mar-97	Jun-98	Mar-07
1,2-DCE (total)	6 J	NA	NA
VC	ND	1.3	ND
trans-1,2-DCE	NA	6.7	ND

A2-MW32B	Mar-00	Mar-07
Chloroform	3.2	ND
VC	6.2	1.3
cis-1,2-DCE	4.2	2.4

A-MW1B	Mar-97	Mar-07
1,1-DCE	6 J	ND
1,2-DCA	27	4.2
1,2-DCE (total)	930	NA
Benzene	3 J	2.3
Chlorobenzene	ND	1.4
Cyclohexane	NA	0.63
TCE	6 J	ND
VC	240	280
cis-1,2-DCE	NA	2.7
trans-1,2-DCE	NA	2.3

A-MW19B	Mar-97	Jun-98	Mar-02
1,2-Dichloropropane	ND	4.9	ND
1,4-Dichlorobenzene	NA	ND	0.25 J
Chlorobenzene	ND	ND	0.51
Cyclohexane	NA	NA	0.26 J
Methylcyclohexane	NA	NA	0.15 J
VC	3 J	0.9 J	0.28 J
cis-1,2-DCE	NA	ND	0.95
trans-1,2-DCE	NA	2.7	0.16 J

VOCs	MCLs (µg/L)
1,1,1-Trichloroethane	200
1,2-Dichloroethane (1,2-DCA)	5
Benzene	5
Ethylbenzene	700
Tetrachloroethene (PCE)	5
Toluene	1,000
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2
Xylene, total	10,000
cis-1,2-Dichloroethene (cis-1,2-DCE)	70

A2-MW28B	Mar-97	Mar-07
1,1-DCE	3 J	0.49 J
1,2-Dichlorobenzene	NA	0.41 J
1,2-DCA	7 J	1.4
1,2-DCE (total)	320	NA
Benzene	2 J	0.88
Chlorobenzene	3 J	2.7
Cyclohexane	NA	0.36 J
TCE	31	ND
VC	96 J	55
cis-1,2-DCE	NA	120
trans-1,2-DCE	NA	3.5

A-MW16B	Jun-98	Mar-07
1,2-Dichloropropane	3.4	ND

A-MW1C	Mar-97	Mar-02
cis-1,2-DCE	NA	0.28 J

A2-MW23B	Mar-97	Mar-07
1,1-DCE	4 J	ND
1,2-DCA	21	3.6
1,2-DCE (total)	330	NA
Benzene	4 J	ND
TCE	60	ND
VC	71	7.2
cis-1,2-DCE	NA	20

A2-MW11B	Jun-98	Mar-07
1,2-Dichloropropane	5	ND

B-MW34B	Mar-00	Mar-07
1,1-DCA	ND	0.42 J
1,2-DCA	ND	6.1
Benzene	ND	4.2
Carbon disulfide	1	ND
Chloroform	5.9	ND
TCE	ND	1.9
VC	ND	3.5
cis-1,2-DCE	ND	17

A-MW15B	Mar-97	Jun-98	Mar-07
1,2-DCE (total)	8 J	NA	NA
1,2-Dichloropropane	ND	3.4	ND
Bromomethane	ND	0.9 J	ND
Chloromethane	ND	99 J	ND
TCE	ND	0.9 J	ND
VC	ND	2.8	ND
cis-1,2-DCE	NA	ND	2.4
trans-1,2-DCE	NA	14	ND

A1-MW24B	Mar-97	Mar-07
1,2-DCE (total)	68	NA
TCE	26	0.35 J
VC	5 J	0.79
cis-1,2-DCE	NA	17
trans-1,2-DCE	NA	9.4

A1-MW10B	Mar-97	Mar-07
1,1-DCE	ND	0.63
1,2-DCE (total)	63	NA
Benzene	ND	0.31 J
Chlorobenzene	ND	2
MTBE	NA	2.1
TCE	8 J	0.45 J
VC	ND	5.3
cis-1,2-DCE	NA	62
trans-1,2-DCE	NA	11

B-MW2C	Mar-97	Mar-04
1,2-DCA	ND	2.6

B-MW3B	Mar-97	Mar-07
1,1-DCA	32	87
1,1-DCE	11	25 J
1,2-Dichlorobenzene	NA	0.44 J
1,2-DCA	550	350
1,2-DCE (total)	100	NA
1,4-Dichlorobenzene	NA	1.3
Benzene	180	210
Chlorobenzene	4 J	5.3
Cyclohexane	NA	0.97 J
Freon-12	NA	79
Methylcyclohexane	NA	0.89 J
PCE	ND	8.6
Toluene	ND	0.75
TCE	120	660
Freon-11	NA	10 J
VC	10	120
cis-1,2-DCE	NA	590
trans-1,2-DCE	NA	1.7 J

A-MW14B	Mar-97	Jun-98	Mar-07
1,2-Dichloropropane	ND	3.6	ND

A1-MW9B	Mar-97	Mar-07
1,2-Dichlorobenzene	0.38 J	0.35 J
1,2-DCE (total)	90	NA
1,4-Dichlorobenzene	0.31 J	ND
Chlorobenzene	1.9	1.6
MTBE	4.8	3.8
TCE	5 J	ND
VC	22	20
cis-1,2-DCE	28 J	24
trans-1,2-DCE	5.9	4.7

A-MW13B	Jun-98	Mar-07
1,2-Dichloropropane	3.5	ND

A-MW31B	Jun-98	Mar-07
VC	4.3	ND
trans-1,2-DCE	2.1	ND

A1-MW25B	Mar-97	Mar-07
1,2-DCE (total)	260	NA
TCE	5 J	ND
VC	220	3.7 J
cis-1,2-DCE	NA	4.4

A1-MW31B	May-99	Mar-06
1,1-DCE	ND	0.11 J
Acetone	1.7 J	ND
Benzene	ND	0.11 J
MTBE	NA	0.13 J
TCE	ND	1.2
VC	ND	1.8
cis-1,2-DCE	ND	13
trans-1,2-DCE	ND	0.33 J

A1-MW6B	Mar-97	Mar-07
1,2-DCE (total)	13	NA
TCE	ND	0.47 J
VC	11	0.38 J
cis-1,2-DCE	NA	5.7

A-MW4B	Mar-06	Mar-07
Chloromethane	0.1 J	ND
Ethylbenzene	0.1 J	ND
Xylene, total	1.3	ND

B-MW2B	Mar-97	Mar-07
1,2-DCA	1,500	0.96
Acetone	ND	10 J
Chlorobenzene	ND	0.45 J

B-MW11B	Mar-97	Mar-07
1,1-DCA	ND	0.86
1,1-Dichloroethene	ND	0.73
1,2-DCA	ND	10
1,2-DCE (total)	26	NA
Benzene	ND	3.3 J
Chloroform	ND	0.46 J
Freon-12	NA	1.1
PCE	ND	0.34 J
TCE	31	39
Freon-11	NA	14
VC	9 J	8.3
cis-1,2-DCE	NA	23

B-MW33B	Apr-00	Mar-07
1,1-DCA	5.4	ND
1,1-DCE	2.9	ND
1,2-DCA	57	ND
Acetone	13	ND
Benzene	42	ND
Chloroform	9	ND
Toluene	6.1	ND
TCE	30	ND
VC	1.5	ND
cis-1,2-DCE	15	ND

Camp Allen Landfill Area A

Camp Allen Landfill Area B

Interstate 564

Ingersol Avenue

C Street

Elementary Drive

A2-EW3B, B-15WB, A1-MW27B, A1-EW2B, A1-EW3B, A1-EW1B, A1-MW26B, A1-MW8C, A1-MW8B, A1-EW4B, B-MW8B, B-MW9B, B-EW4B, B-EW1B, B-MW2B, B-EW3B, B-EW2B, B-MW22B, B-MW1B

LEGEND

- Deep Monitoring Well
- Deep Monitoring Well not included in LTM
- Active Extraction Well
- Inactive Extraction Well
- Land Use Control Area
- Deep Aquifer Groundwater Plume

← Direction of Groundwater Flow (May 2007)

February 2005 Aerial Photography

NA - Not analyzed

ND - Not detected

J - Reported value is estimated

MTBE - Methyl-tert-butyl ether

VOC - Volatile organic compounds

N

0 400 800 Feet

Notes: Units are in micrograms per liter (µg/L).

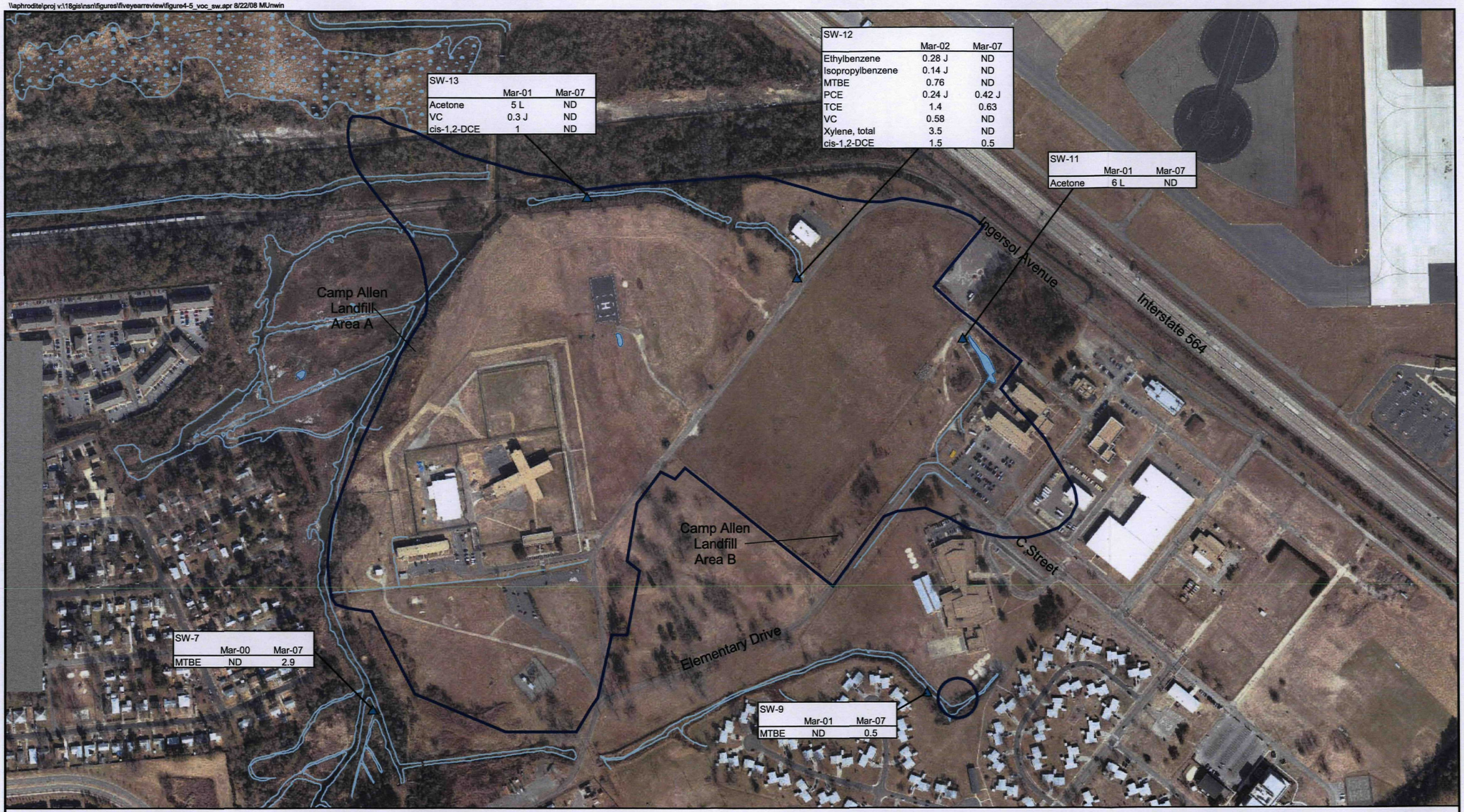
The detected concentration values that exceed MCL values are highlighted.

This figure only shows the detected VOCs from the first and last rounds of sampling at each sampling location.

Figure 4-4
Site 1 - VOCs in Deep Monitoring Wells
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\fiveyearreview\figure4-5_voc_sw.apr 8/22/08 MUnwin



LEGEND

- ▲ Surface Water Sample Location
- Land Use Control Area
- Surface Water Features

Notes: Units are in micrograms per liter (µg/L).
This figure only show the detected VOCs from the first and last round of sampling at each sampling location.
February 2005 Aerial Photography

MTBE - Methyl-tert-butyl ether
PCE - Tetrachloroethene
TCE - Trichloroethene
cis-1,2-DCE - cis-1,2-Dichloroethene
VC - Vinyl Chloride
ND - Not detected
J - Reported value is estimated
L - Reported value may be biased low

N

0 400 800 Feet

Figure 4-5
Site 1 - VOCs in Surface Water
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 5

Site 2—NM Slag Pile

5.1 Site 2 Chronology

Below is the chronology of the major site events for Site 2, NM Slag Pile.

1950s-'60s	Disposal of slag, fly ash, and/or bottom ash at the site
1983	Slag Pile identified as a potential source of contamination in the IAS
April 1997	NSN placed on the NPL
August 1998	RI completed
September 1998	FS completed
January 1999	PRAP completed
September 1999	Remedial Action Design completed
November 1999	Sediment removal action completed
February 2000	Placement of the soil and asphalt cover was completed
October 2000	Implementation of annual LTM
December 2000	ROD signed
October 2003	Implementation of Five-Year Review process
January 2005	Final RD for LUCs at Site 2
June 2007	Remedial Action Completion Report

5.2 Site 2 Background

Site 2, the NM Slag Pile, is located in the southeast portion of NSN, near the intersection of Interstate-64 and Interstate-564 (**Figure 2-1**). The site is bordered by Patrol Road to the southwest, the fenced NM Van Facility to the southeast, and a fenced weapons storage area to the northeast (**Figure 5-1**). Site 2 is located within a broad open area adjacent to a remnant pine forest and is intended to remain an open space to serve as a buffer zone around the weapons area (EDAW, August 1995). The drainage channel adjacent to the site conveys water from the upstream watershed, the site stormwater runoff, and the shallow water table aquifer underlying the site. Prior to remediation activities, the site's surface consisted of a gravel parking lot and open grassy field. As part of remediation activities, the site's surface has since been regraded and vegetation planted. The site's surface currently consists of a paved parking lot and a vegetated field which remains unused, but is periodically mowed.

The NM Slag Pile was a 1-acre area used for the disposal of slag generated by an aluminum smelting operation during the 1950s and 1960s. The slag was a residual cinder material formed from the fusion of a mineral such as limestone with impurities from the aluminum ore and ash from the blast-furnace fuel. To create a level surface upon which the slag could be deposited, fly ash and/or bottom ash (derived from coal burning operations elsewhere at NSN) was also used as fill material at the site. During the smelting operation, the slag pile area was defined by a lack of vegetation around the site near the slag pile.

The potential for site contamination from metals—including chromium, cadmium, and zinc—was identified in the IAS (ESE, February 1983). Trace amounts of inorganic constituents were detected in surface soil, surface water, and sediment samples collected during the Interim RI (Malcolm Pirnie, May 1988). However, the samples were collected after site regrading and placement of gravel surfacing. Since these activities disturbed the surface soil, the analytical results may not be representative of activities at the site.

The 1998 RI (CH2M HILL, June 1998a) conducted at Site 2 concluded that the disposal activities had impacted the groundwater and soil as well as sediment and surface water in the adjacent drainage channel. In correlation with the type of material disposed of at the site, the primary contaminants consist of metals—arsenic, antimony, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc. Considerable concentrations of the organic chemicals dichlorodiphenyldichloroethylene (4,4'-DDE) and trichloroethene were also detected. Sediment and surface soil sampling was conducted in February 1998 to delineate the contamination limits for a sediment removal action. A risk assessment report was based on data presented in the RI report. The HHRA was conducted on the constituents that were detected at Site 2 and had available toxicological values. The baseline risk assessment assessed the potential human health impacts from the site under current conditions. All of the cumulative carcinogenic and noncarcinogenic hazards are below or within the USEPA's recommended levels except for construction worker exposure. If construction were to occur at Site 2, there may be a hazard to construction workers exposed to the surface soil.

An ecological risk assessment was conducted by using hazard quotient values generated for receptor species from maximum and mean concentrations of constituents of potential concern (COPC) in soil, sediment, and surface water. USEPA ecological risk guidance suggests that values equal to or greater than 1.0 represent a "potential ecological risk". Based on the results of the ecological screening risk assessment, "potential ecological risk" existed at Site 2 from the following metals "aluminum, antimony, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

5.3 Site 2 Remedial Actions

5.3.1 Remedy Selection

The FS was submitted in 1998 (CH2M HILL, September 1998c) and the PRAP was issued in 1999 (CH2M HILL, January 1999a). The Remedial Action Design was completed in 1999 (CH2M HILL, September 1999b) and the ROD was signed in December 2000 (CH2M HILL, October 2000b). The ROD identified the risks to human health and the environment, established the RAOs, and defined the selected remedy. The purpose of the selected remedy

was to minimize exposure to contamination present in the soil, groundwater, surface water, and sediment. The selected remedy for Site 2 includes an asphalt and soil cover, LTM, and LUCs to meet the following RAOs:

- Prevent or minimize human health exposure to inorganic contaminants in the subsurface soil above health-based criteria.
- Prevent degradation of groundwater quality by limiting downward percolation of precipitation into the water table aquifer beneath Site 2.
- Minimize the risk to ecological receptors posed by lead-contaminated sediment and surface water.
- Prevent further migration of contaminated sediment from the site.

The ROD selected the following LUC objectives for Site 2:

- Prohibit excavating or disturbing the asphalt and soil covers, provided the sewage main traversing the site may be maintained from time to time, as necessary or appropriate.
- Prohibit the use of groundwater underlying the site for drinking water.
- Prohibit any other activity that would disturb the integrity of the asphalt and soil covers or impair the function of groundwater monitoring systems.

These LUC restrictions have been implemented with the actions detailed in the RD for LUCs at Site 2 (CH2M HILL, January 2005a). The LUCs shall be maintained on the soil and asphalt cover and groundwater within the boundaries of Site 2 until they are no longer required to protect human health or the environment, as stipulated in the ROD.

Lead was considered the indicator parameter for the sediment COCs, and since it was co-located with the other COCs, the removal of lead to the established cleanup level was expected to remove the other elevated contaminants posing a risk. The lead cleanup goal for sediment was 218 milligrams per kilogram (mg/kg) and was based on the Effects Range-Median (ERM) concentration.

5.3.2 Remedy Implementation

Remedial action construction was completed from August 1999 through February 2000. The extent of the sediment removal, asphalt cover, and soil cover are shown in **Figure 5-1.** Approximately 1,600 tons of sediment were removed to achieve the lead cleanup goal of 218 mg/kg. A rip rap lining was placed at channel junctions, a rip rap apron was placed around the culvert of the channel segment, and a 100-ft section of the west bank of the drainage channel was regraded, seeded, and covered with matting and a 24-inch soil cover to prevent erosion of site materials. The asphalt cover consisted of a minimum of 8 inches of stone and 2 inches of asphalt placed over the original gravel parking lot. The soil cover consisted of a minimum of 18 inches of common fill and 4 inches of topsoil that was placed over the grassy field.

In accordance with the ROD, Site 2 is part of the LTM program at NSN. The LTM plan for Site 2 required sampling and analysis of inorganic constituents subsequent to the implementation of the remedial action. Samples were collected in sediment, surface water,

and groundwater once a year for 5 years and in groundwater once every 5 years thereafter. Sediment and surface water sample locations were selected such that they could be sampled over time to allow for the completion of a trend analysis to evaluate changes in concentrations over time. As detailed in the 2007 LTM Plan (CH2M HILL, May 2007e), one additional sediment sampling event was completed to provide further data for constituent trend analysis. Statistical methods to evaluate the effectiveness of the remedy are detailed in the 2007 LTM Plan (CH2M HILL, May 2007e).

5.3.3 System Operation and Maintenance

Current site maintenance consists of periodically mowing the cover of the grass field.

5.4 Site 2 Progress Since Last Review

The previous Rive-Year Review deemed the remedy for Site 2 protective of human health and the environment under the current industrial land use, and there were no recommendations or follow-up actions identified (CH2M HILL, October 2003).

Since the previous Five-Year Review, quarterly site inspections have been completed and the LTM program has continued as detailed in the ROD. One additional round of sediment samples was collected in 2007 to support this Five-Year Review.

5.5 Site 2 Five-Year Review Process

5.5.1 Long-term Monitoring Data Review

The LTM program was implemented as a requirement of the ROD (CH2M HILL, October 2000b) for Site 2 to evaluate the effectiveness of the remedial action. Baseline groundwater samples were collected in 1997 and groundwater, surface water, and sediment samples were collected annually for 5 years (2000 through 2004) to monitor the concentrations of metals at the site and determine if these constituents were migrating offsite to the adjacent drainage channel. One additional round of sediment samples was collected in 2007.

Groundwater Monitoring

Total and dissolved metals detected in the baseline and the 2004 round of groundwater sampling are shown on **Figure 5-2**. Following the initial 5 years of LTM (2000 through 2004), a statistical analysis of the data to evaluate trends and determine if metals were migrating offsite was completed. Statistical analytical results concluded that concentrations of metals in groundwater showed a decreasing trend since the remedial action (CH2M HILL, May 2007e). Therefore, based on the ROD and statistical analysis as well as agreement by the NSN Tier I Partnering Team during the May 2005 meeting, the LTM groundwater sampling has been reduced to a frequency of once every 5 years. The next round of groundwater samples are scheduled to be collected in June 2009 and the continuing effectiveness of the remedial action at Site 2 will be evaluated as part of the Five-Year Reviews conducted at the facility.

Surface Water and Sediment Monitoring

Once the initial 5 years of LTM was completed for surface water and sediment (2000 to 2004), a statistical analysis of the data was completed to evaluate trends and determine if metals were migrating offsite. Statistical analytical results indicate that after initially decreasing significantly for most of these constituents, metal concentrations in surface water have been relatively stable since the remedial action was completed (CH2M HILL, May 2007e). **Figures 5-3** and **5-4** show the first and last round of total and dissolved metal concentrations in surface water, respectively. Based on the ROD, the statistical analysis, as well as agreement by the NSN Tier I Partnering Team during the May 2005 meeting, surface water sampling was discontinued.

Statistical analytical results for metal concentrations in sediment indicate most inorganic constituents decreased significantly and then remained relatively stable following the implementation of the remedial action (CH2M HILL, May 2007e). Lead is the indicator chemical for the sediment action and lead concentrations detected in the first and last round at each sampling location are shown on **Figure 5-5.** Lead concentrations have sporadically (spatially and temporally) exceeded the cleanup level four times (in 30 total samples) during the first five rounds of the LTM, once in Round 1 (2000) at SD45, twice in Round 4 (2003) at SD46 and SD41, and once in Round 5 (2004) at SD45. Therefore, the NSN Tier I Partnering Team agreed in May 2005 that one additional round of sediment sampling would be completed in 2007 to evaluate lead concentrations in three of the sediment samples locations (SD41, SD45, and SD46) that had sporadic lead concentrations exceeding the remedial level. Lead was detected in all three 2007 samples; however, the lead concentrations did not exceed the cleanup level of 218 mg/kg (the concentrations were 115, 48.3, and 10.4 mg/kg, respectively). While there has been some fluctuation in the sediment concentrations for lead in the LTM data, there has been no consistent temporal or spatial trend. In addition, the magnitude and frequency of exceedances has been low (four of 33 total samples at a maximum ratio of less than two). Thus, following the additional round of sediment sampling and the results of the trends analysis of the LTM data, the NSN Tier I Partnering Team agreed the performance standards in the ROD have been met and sediment sampling could be discontinued.

5.5.2 Site Inspections

Site inspections have been conducted at Site 2 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review.

During the May 2005 inspection a hole was observed in the northwestern corner of the asphalt parking lot. To maintain the integrity of the asphalt cover the hole was repaired as documented during the February 2006 inspection. The most recent inspection was conducted in February 2008 and no discrepancies were noted. No additional deficiencies were observed. Photographs taken during the February 2008 site inspections are included in **Appendix A.**

5.5.3 Site Interviews

There is no active system at Site 2 and consequently no operator responsible for system maintenance. Therefore no interviews were needed for this site.

5.6 Site 2 Technical Assessment

Is the remedy functioning as intended by the DDs?

Based on the review of the documents, monitoring results, ARARs, risk assumptions and results of the inspections, the remedy is functioning as intended by the ROD. The stabilization and capping of contaminated soil and sediment has achieved the remedial objectives as demonstrated by the monitoring results. In accordance with the ROD requirements for Site 2, sampling of surface water and sediment has been discontinued and groundwater monitoring has been reduced to once every 5 years. There is re-growth of vegetation on the soil cover and the asphalt cover has been repaired. No other disturbances to the covers were identified. Implementation and maintenance of ICs has prevented exposure to contaminated media.

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-Year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 2, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the RA or the classes of constituents identified as COCs. The remediation goals for the subsurface soil were based on a construction worker exposure scenario and were used to help determine the extent of the asphalt and soil cover. Although some of the toxicity numbers used to calculate the remediation goals have changed slightly (chromium oral reference dose [RfD] is now lower, iron oral RfD is now higher), these slight changes do not effect the effectiveness of the remedy. The ER-M value (218 mg/kg) that was used as the sediment lead removal level has not changed.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 2. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

Residential use of groundwater was not evaluated in the HHRA, as it was considered an incomplete pathway. It is current practice to evaluate future residential use of groundwater, even though it may not be a likely future scenario, as an evaluation of unrestricted site use. However, evaluation of this scenario would not change the effectiveness of the remedy, as ICs are in place and prevent use of and exposure to the groundwater at Site 2. Additionally, since the placement of the cover, the concentrations of the inorganic constituents in

groundwater samples collected as part of the LTM program showed a decreasing concentration trend. Furthermore, the cover and ICs prevent any exposure to surface or subsurface soil. Therefore, the remedy is still considered to be protective.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

5.7 Site 2 Issues Identified

Table 5-1 presents the issues that have been identified for Site 2 based on this Five-Year Review.

TABLE 5-1
Issues for Site 2
Naval Station Norfolk

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
During the May 2005 inspection a hole was observed in the northwestern corner of the asphalt parking lot. To maintain the integrity of the asphalt cover the hole was repaired as documented during the February 2006 inspection.	N	N

5.8 Site 2 Recommendations and Follow-up Actions

Table 5-2 presents the recommendations and follow-up actions for Site 2 based on this Five-Year Review.

TABLE 5-2
Recommendations and Follow-up Actions for Site 2
Naval Station Norfolk

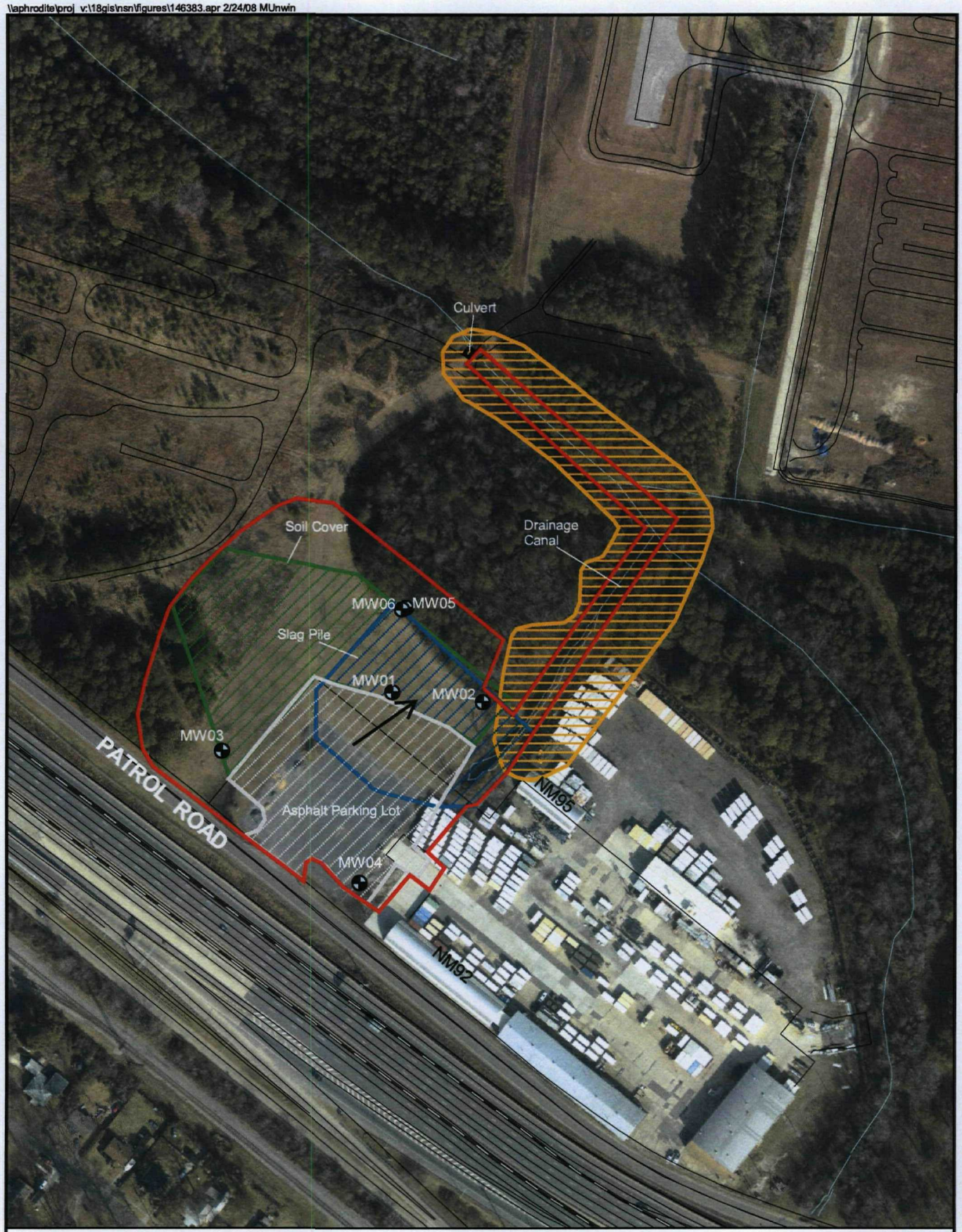
Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date	Affects Protectiveness (Y/N)	
				Current	Future
During the May 2005 inspection a hole was observed in the northwestern corner of the asphalt parking lot. To maintain the integrity of the asphalt cover the hole was repaired as documented during the February 2006 inspection.	Repair holes promptly and conduct inspections to ensure integrity of the cover. The Hole was repaired as documented in the February 2006 inspection	Navy EPA VDEQ	Summer 2005	N	N

5.9 Site 2 Protectiveness Statement

The cover remedy soil and sediment at Site 2, NM Area Slag Pile, prevents direct contact with soil and sediment. Supporting inspection information and monitoring data indicate the

landfill cover is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in unacceptable risks are being controlled through a combination of existence of the cover, LUCs, and the implementation of ICs.

\\aphrodite\proj_v:\18gis\nsn\figures\146383.apr 2/24/08 MUnwin



LEGEND

- Monitoring Well
- Land Use Control Area
- Areas of Sediment Removal
- Area of Soil Cover
- Area of Asphalt Cover
- Approximate Location of Slag Pile Area

← Direction of Groundwater Flow (April 1997)

February 2005 Aerial Photography

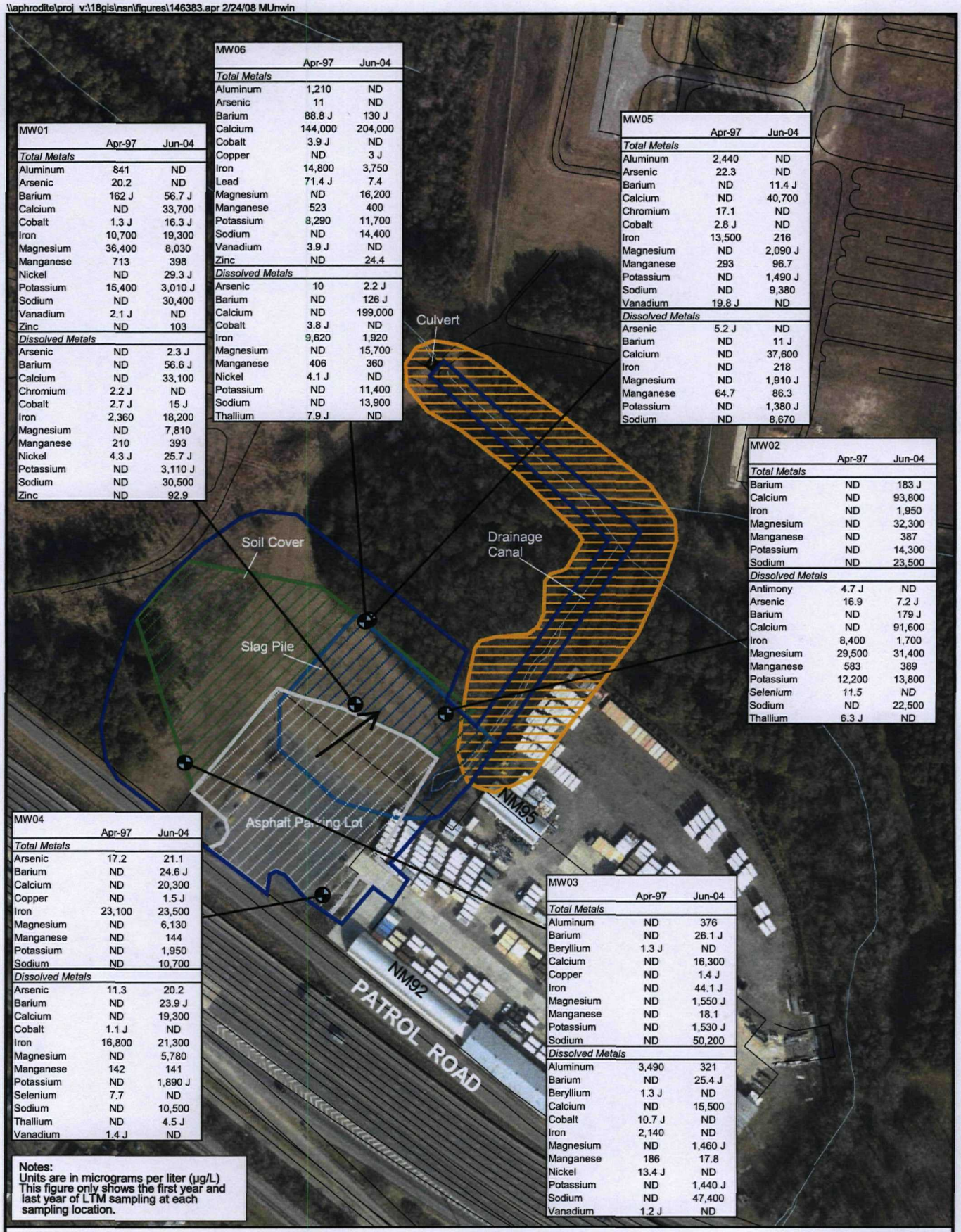
N

0 100 200 Feet

Figure 5-1
Site 2 - NM Slag Pile
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj_v:\18gis\nsn\figures\146383.apr 2/24/08 MUnwin



MW01	Apr-97	Jun-04
Total Metals		
Aluminum	841	ND
Arsenic	20.2	ND
Barium	162 J	56.7 J
Calcium	ND	33,700
Cobalt	1.3 J	16.3 J
Iron	10,700	19,300
Magnesium	36,400	8,030
Manganese	713	398
Nickel	ND	29.3 J
Potassium	15,400	3,010 J
Sodium	ND	30,400
Vanadium	2.1 J	ND
Zinc	ND	103
Dissolved Metals		
Arsenic	ND	2.3 J
Barium	ND	56.6 J
Calcium	ND	33,100
Chromium	2.2 J	ND
Cobalt	2.7 J	15 J
Iron	2,360	18,200
Magnesium	ND	7,810
Manganese	210	393
Nickel	4.3 J	25.7 J
Potassium	ND	3,110 J
Sodium	ND	30,500
Zinc	ND	92.9

MW06	Apr-97	Jun-04
Total Metals		
Aluminum	1,210	ND
Arsenic	11	ND
Barium	88.8 J	130 J
Calcium	144,000	204,000
Cobalt	3.9 J	ND
Copper	ND	3 J
Iron	14,800	3,750
Lead	71.4 J	7.4
Magnesium	ND	16,200
Manganese	523	400
Potassium	8,290	11,700
Sodium	ND	14,400
Vanadium	3.9 J	ND
Zinc	ND	24.4
Dissolved Metals		
Arsenic	10	2.2 J
Barium	ND	126 J
Calcium	ND	199,000
Cobalt	3.8 J	ND
Iron	9,620	1,920
Magnesium	ND	15,700
Manganese	406	360
Nickel	4.1 J	ND
Potassium	ND	11,400
Sodium	ND	13,900
Thallium	7.9 J	ND

MW05	Apr-97	Jun-04
Total Metals		
Aluminum	2,440	ND
Arsenic	22.3	ND
Barium	ND	11.4 J
Calcium	ND	40,700
Chromium	17.1	ND
Cobalt	2.8 J	ND
Iron	13,500	216
Magnesium	ND	2,090 J
Manganese	293	96.7
Potassium	ND	1,490 J
Sodium	ND	9,380
Vanadium	19.8 J	ND
Dissolved Metals		
Arsenic	5.2 J	ND
Barium	ND	11 J
Calcium	ND	37,600
Iron	ND	218
Magnesium	ND	1,910 J
Manganese	64.7	86.3
Potassium	ND	1,380 J
Sodium	ND	8,670

MW02	Apr-97	Jun-04
Total Metals		
Barium	ND	183 J
Calcium	ND	93,800
Iron	ND	1,950
Magnesium	ND	32,300
Manganese	ND	387
Potassium	ND	14,300
Sodium	ND	23,500
Dissolved Metals		
Antimony	4.7 J	ND
Arsenic	16.9	7.2 J
Barium	ND	179 J
Calcium	ND	91,600
Iron	8,400	1,700
Magnesium	29,500	31,400
Manganese	583	389
Potassium	12,200	13,800
Selenium	*11.5*	*ND*
Sodium	ND	22,500
Thallium	6.3 J	ND

MW04	Apr-97	Jun-04
Total Metals		
Arsenic	17.2	21.1
Barium	ND	24.6 J
Calcium	ND	20,300
Copper	ND	1.5 J
Iron	23,100	23,500
Magnesium	ND	6,130
Manganese	ND	144
Potassium	ND	1,950
Sodium	ND	10,700
Dissolved Metals		
Arsenic	11.3	20.2
Barium	ND	23.9 J
Calcium	ND	19,300
Cobalt	1.1 J	ND
Iron	16,800	21,300
Magnesium	ND	5,780
Manganese	142	141
Potassium	ND	1,890 J
Selenium	7.7	ND
Sodium	ND	10,500
Thallium	ND	4.5 J
Vanadium	1.4 J	ND

MW03	Apr-97	Jun-04
Total Metals		
Aluminum	ND	376
Barium	ND	26.1 J
Beryllium	1.3 J	ND
Calcium	ND	16,300
Copper	ND	1.4 J
Iron	ND	44.1 J
Magnesium	ND	1,550 J
Manganese	ND	18.1
Potassium	ND	1,530 J
Sodium	ND	50,200
Dissolved Metals		
Aluminum	3,490	321
Barium	ND	25.4 J
Beryllium	1.3 J	ND
Calcium	ND	15,500
Cobalt	10.7 J	ND
Iron	2,140	ND
Magnesium	ND	1,460 J
Manganese	186	17.8
Nickel	13.4 J	ND
Potassium	ND	1,440 J
Sodium	ND	47,400
Vanadium	1.2 J	ND

Notes:
Units are in micrograms per liter (µg/L)
This figure only shows the first year and last year of LTM sampling at each sampling location.

LEGEND

- Monitoring Well
- Land Use Control Area
- Areas of Sediment Removal
- Area of Soil Cover
- Area of Asphalt Cover
- Approximate Location of Slag Pile Area

← Direction of Groundwater Flow (April 1997)

February 2005 Aerial Photography

ND - Not detected
J - Reported value is estimated

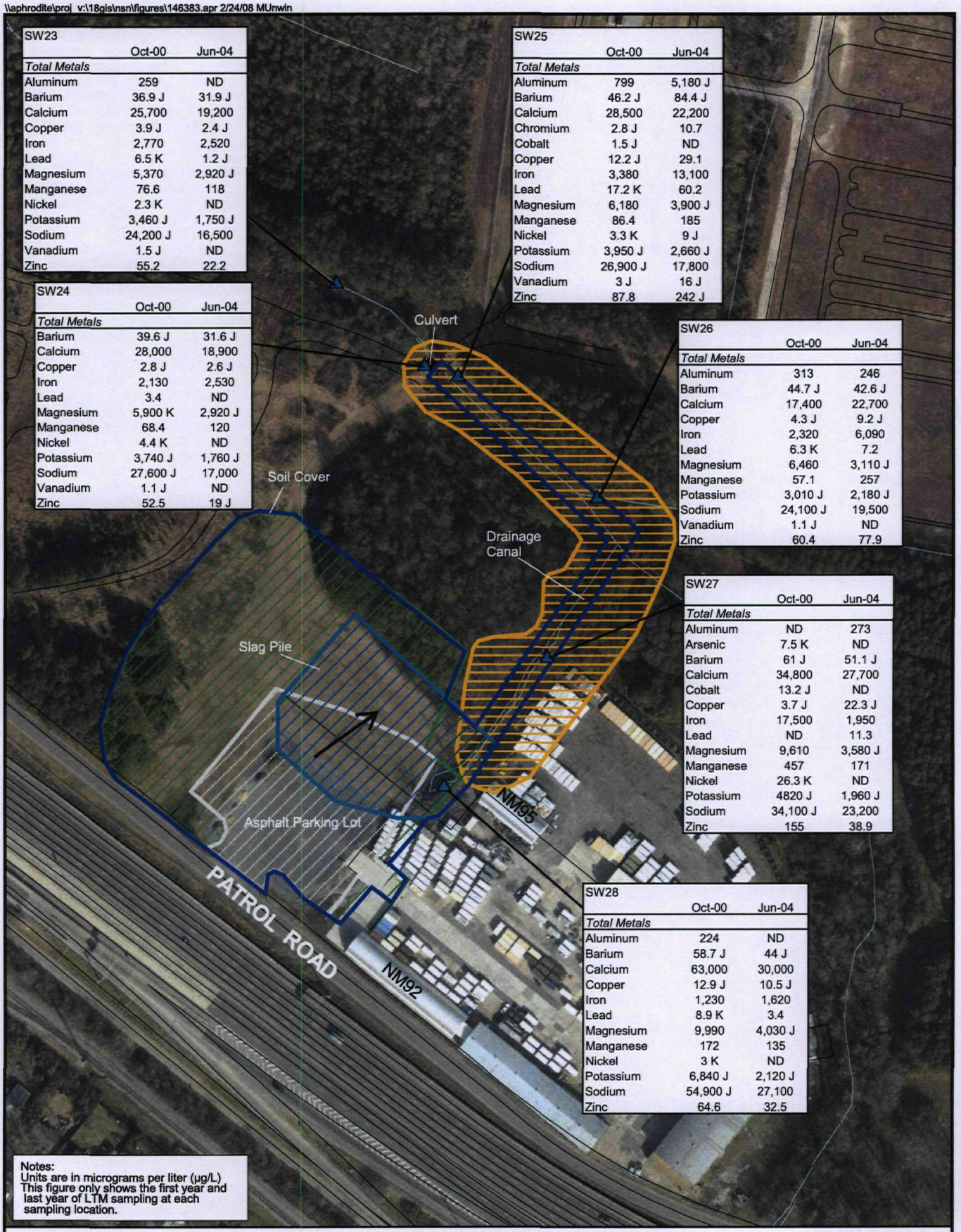
N

0 100 200 Feet

Figure 5-2
Site 2 - Total and Dissolved Metals in Groundwater
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\146383.apr 2/24/08 MUnwin



SW23	Oct-00	Jun-04
Total Metals		
Aluminum	259	ND
Barium	36.9 J	31.9 J
Calcium	25,700	19,200
Copper	3.9 J	2.4 J
Iron	2,770	2,520
Lead	6.5 K	1.2 J
Magnesium	5,370	2,920 J
Manganese	76.6	118
Nickel	2.3 K	ND
Potassium	3,460 J	1,750 J
Sodium	24,200 J	16,500
Vanadium	1.5 J	ND
Zinc	55.2	22.2

SW24	Oct-00	Jun-04
Total Metals		
Barium	39.6 J	31.6 J
Calcium	28,000	18,900
Copper	2.8 J	2.6 J
Iron	2,130	2,530
Lead	3.4	ND
Magnesium	5,900 K	2,920 J
Manganese	68.4	120
Nickel	4.4 K	ND
Potassium	3,740 J	1,760 J
Sodium	27,600 J	17,000
Vanadium	1.1 J	ND
Zinc	52.5	19 J

SW25	Oct-00	Jun-04
Total Metals		
Aluminum	799	5,180 J
Barium	46.2 J	84.4 J
Calcium	28,500	22,200
Chromium	2.8 J	10.7
Cobalt	1.5 J	ND
Copper	12.2 J	29.1
Iron	3,380	13,100
Lead	17.2 K	60.2
Magnesium	6,180	3,900 J
Manganese	86.4	185
Nickel	3.3 K	9 J
Potassium	3,950 J	2,660 J
Sodium	26,900 J	17,800
Vanadium	3 J	16 J
Zinc	87.8	242 J

SW26	Oct-00	Jun-04
Total Metals		
Aluminum	313	246
Barium	44.7 J	42.6 J
Calcium	17,400	22,700
Copper	4.3 J	9.2 J
Iron	2,320	6,090
Lead	6.3 K	7.2
Magnesium	6,460	3,110 J
Manganese	57.1	257
Potassium	3,010 J	2,180 J
Sodium	24,100 J	19,500
Vanadium	1.1 J	ND
Zinc	60.4	77.9

SW27	Oct-00	Jun-04
Total Metals		
Aluminum	ND	273
Arsenic	7.5 K	ND
Barium	61 J	51.1 J
Calcium	34,800	27,700
Cobalt	13.2 J	ND
Copper	3.7 J	22.3 J
Iron	17,500	1,950
Lead	ND	11.3
Magnesium	9,610	3,580 J
Manganese	457	171
Nickel	26.3 K	ND
Potassium	4820 J	1,960 J
Sodium	34,100 J	23,200
Zinc	155	38.9

SW28	Oct-00	Jun-04
Total Metals		
Aluminum	224	ND
Barium	58.7 J	44 J
Calcium	63,000	30,000
Copper	12.9 J	10.5 J
Iron	1,230	1,620
Lead	8.9 K	3.4
Magnesium	9,990	4,030 J
Manganese	172	135
Nickel	3 K	ND
Potassium	6,840 J	2,120 J
Sodium	54,900 J	27,100
Zinc	64.6	32.5

Notes:
Units are in micrograms per liter (µg/L)
This figure only shows the first year and last year of LTM sampling at each sampling location.

LEGEND

- Surface Water Location
- Land Use Control Area
- Areas of Sediment Removal
- Area of Soil Cover
- Area of Asphalt Cover
- Approximate Location of Slag Pile Area

← Direction of Groundwater Flow (April 1997)

February 2005 Aerial Photography

ND - Not detected
J - Reported value is estimated
K - Reported value may be biased high

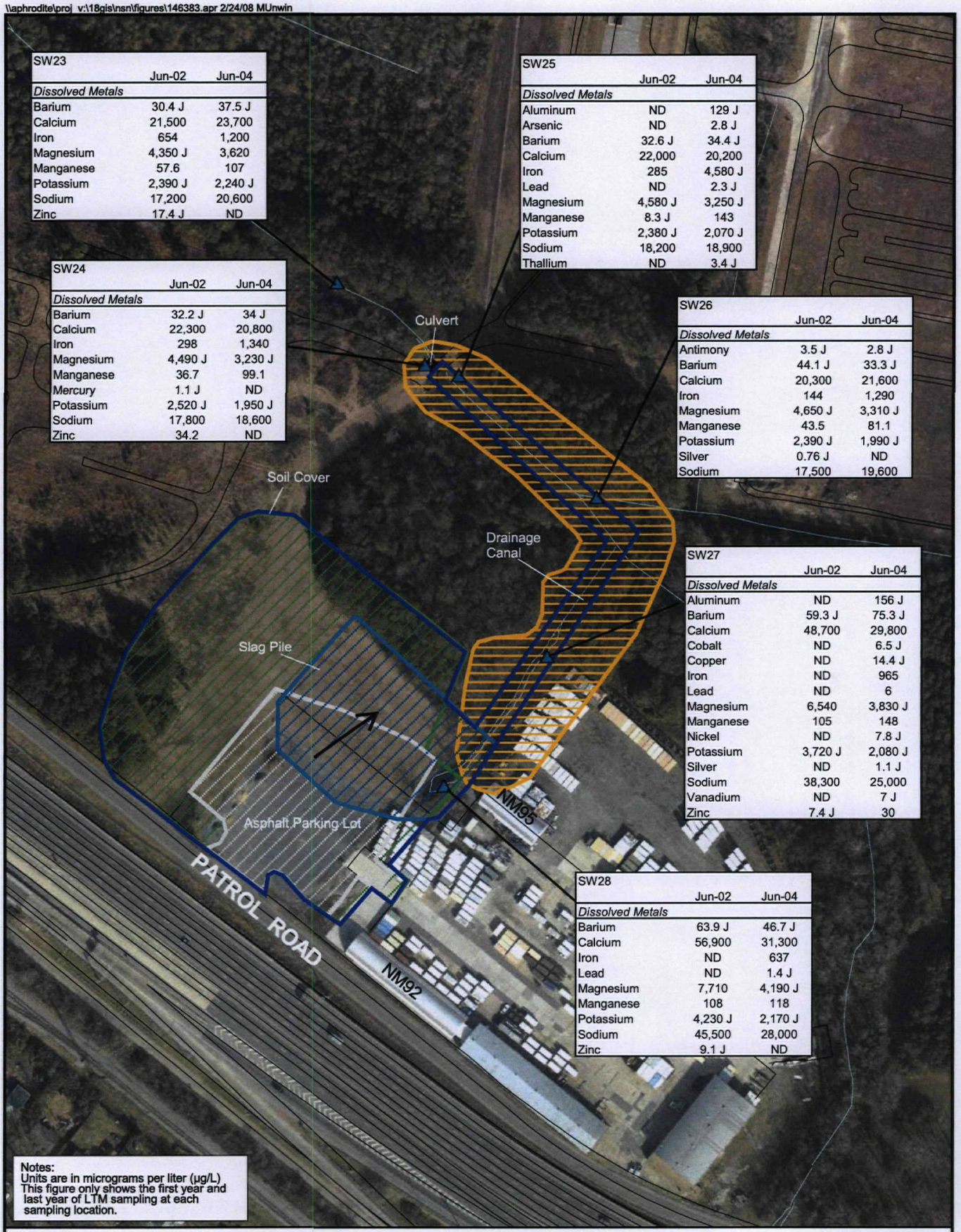
N

0 100 200 Feet

Figure 5-3
Site 2 - Total Metals in Surface Water
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\146383.apr 2/24/08 MUnwin



SW23	Jun-02	Jun-04
Dissolved Metals		
Barium	30.4 J	37.5 J
Calcium	21,500	23,700
Iron	654	1,200
Magnesium	4,350 J	3,620
Manganese	57.6	107
Potassium	2,390 J	2,240 J
Sodium	17,200	20,600
Zinc	17.4 J	ND

SW24	Jun-02	Jun-04
Dissolved Metals		
Barium	32.2 J	34 J
Calcium	22,300	20,800
Iron	298	1,340
Magnesium	4,490 J	3,230 J
Manganese	36.7	99.1
Mercury	1.1 J	ND
Potassium	2,520 J	1,950 J
Sodium	17,800	18,600
Zinc	34.2	ND

SW25	Jun-02	Jun-04
Dissolved Metals		
Aluminum	ND	129 J
Arsenic	ND	2.8 J
Barium	32.6 J	34.4 J
Calcium	22,000	20,200
Iron	285	4,580 J
Lead	ND	2.3 J
Magnesium	4,580 J	3,250 J
Manganese	8.3 J	143
Potassium	2,380 J	2,070 J
Sodium	18,200	18,900
Thallium	ND	3.4 J

SW26	Jun-02	Jun-04
Dissolved Metals		
Antimony	3.5 J	2.8 J
Barium	44.1 J	33.3 J
Calcium	20,300	21,600
Iron	144	1,290
Magnesium	4,650 J	3,310 J
Manganese	43.5	81.1
Potassium	2,390 J	1,990 J
Silver	0.76 J	ND
Sodium	17,500	19,600

SW27	Jun-02	Jun-04
Dissolved Metals		
Aluminum	ND	156 J
Barium	59.3 J	75.3 J
Calcium	48,700	29,800
Cobalt	ND	6.5 J
Copper	ND	14.4 J
Iron	ND	965
Lead	ND	6
Magnesium	6,540	3,830 J
Manganese	105	148
Nickel	ND	7.8 J
Potassium	3,720 J	2,080 J
Silver	ND	1.1 J
Sodium	38,300	25,000
Vanadium	ND	7 J
Zinc	7.4 J	30

SW28	Jun-02	Jun-04
Dissolved Metals		
Barium	63.9 J	46.7 J
Calcium	56,900	31,300
Iron	ND	637
Lead	ND	1.4 J
Magnesium	7,710	4,190 J
Manganese	108	118
Potassium	4,230 J	2,170 J
Sodium	45,500	28,000
Zinc	9.1 J	ND

Notes:
Units are in micrograms per liter (µg/L)
This figure only shows the first year and last year of LTM sampling at each sampling location.

LEGEND
- Surface Water Location
- Land Use Control Area
- *Areas of Sediment Removal*
- Area of Soil Cover
- Area of Asphalt Cover
- Approximate Location of Slag Pile Area

← Direction of Groundwater Flow (April 1997)

February 2005 Aerial Photography

ND - Not detected
J - Reported value is estimated

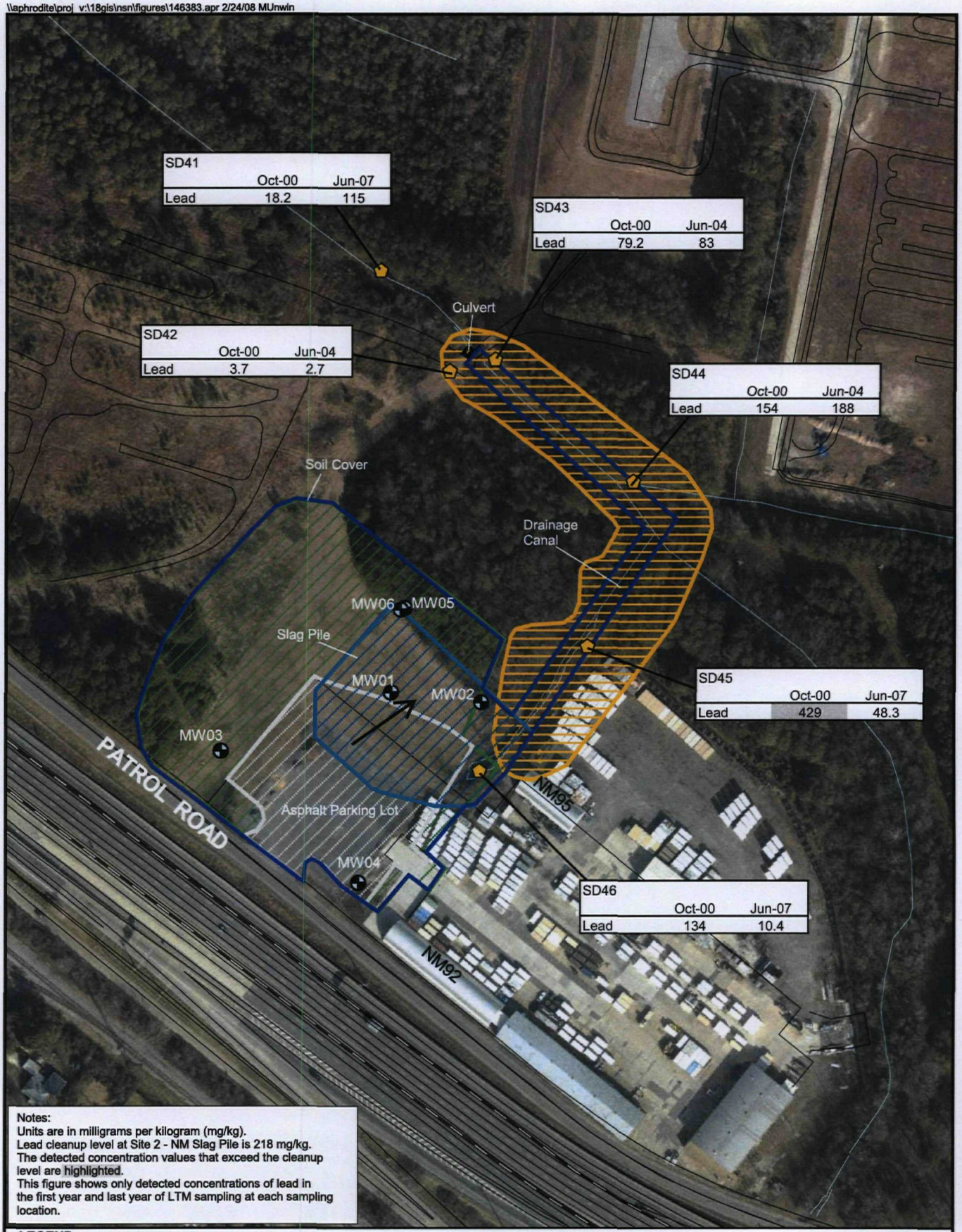
N

0 100 200 Feet

Figure 5-4
Site 2 - Dissolved Metals in Surface Water
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\146383.apr 2/24/08 MUnwin



Notes:
Units are in milligrams per kilogram (mg/kg).
Lead cleanup level at Site 2 - NM Slag Pile is 218 mg/kg.
The detected concentration values that exceed the cleanup level are highlighted.
This figure shows only detected concentrations of lead in the first year and last year of LTM sampling at each sampling location.

LEGEND

- Sediment Sample Location
- Monitoring Well
- Land Use Control Area
- Areas of Sediment Removal
- Area of Soil Cover
- Area of Asphalt Cover
- Approximate Location of Slag Pile Area
- ← Direction of Groundwater Flow (April 1997)

February 2005 Aerial Photography

N

0 100 200 Feet

Figure 5-5
Site 2 - Lead in Sediment Samples
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 6

Site 3—Q Area Drum Storage Yard

6.1 Site 3 Chronology

Below is the chronology of the major site events for Site 3, Q Area Drum Storage Yard.

1950s-80s	Area was used to store drums
1983	Area identified as a potential source of contamination in the IAS
1987	Soil removal action completed
1988	Interim RI completed
1996	RI/FS completed
1996	PRAP completed and DD signed
April 1997	NSN placed on the NPL
1997	Construction of the air sparge/soil vapor extraction (AS/SVE) system
August 1998	Remediation system began operation
February 1999	Implementation of the biannual LTM
September 1999	System operation was modified to a 2-week cycle of pulsing
April 2003	Closeout Strategy was implemented for Area of Concern (AOC) 1
October 2003	Implementation of Five-Year Review process
June 2006	Closeout Strategy was implemented for AOC 2
April 2007	Final RD for LUCs at Site 2

6.2 Site 3 Background

The Site 3, QADSY, occupied approximately 5 acres in the northwest corner of NSN near the aircraft carrier piers (**Figures 2-1 and 6-1**). This area was created by dredging operations in the early 1950s. The topography of the area is relatively uniform, characterized by flat sloping areas. The average elevation of the site is about 10 ft amsl. Two large water bodies are located adjacent to Site 3. The Elizabeth River borders the western boundary of the site and Willoughby Bay borders the northern and eastern boundary of the site. The water table is approximately 8 ft below ground surface (bgs), and water table elevations range from 2 to 5 ft amsl and groundwater flow is west across the site. The underlying Yorktown Aquifer is hydraulically connected to the Columbia aquifer at this site. The Yorktown aquifer discharges into the Elizabeth River and Willoughby Bay; however these bodies of water are

not used for domestic public, commercial, or industrial supply because the water is brackish.

Site 3 was an open earthen yard used from the 1950s until the late '80s to store tens of thousands of drums, most of which contained new petroleum products, various chlorinated organic solvents, paint thinners, and pesticides. The drums have since been removed and the site currently serves as a fleet parking area.

The potential for site contamination from drum storage activities was initially identified in the 1983 IAS (ESE, February 1983). The initial site visit noted dark stains on the soil and oil-saturated soil throughout the storage yard, indicative of past spills. The yard's northern portion, which was used to store leaking or damaged drums and hazardous materials, was particularly stained. Field investigations were conducted from 1983 to 1986 to characterize the nature and extent of contamination at the site. The analytical results indicated that soil and groundwater were contaminated with metals and VOCs (Malcolm Pirnie, May 1988).

In 1986, Navy fire inspectors expressed concern with the oil-saturated soils at the northern end of the storage area (previously used to store damaged or leaking drums). On the basis of a potential fire hazard, the top 6 inches of soil were excavated in the northern section from an area of 4,240 square yards (yd^2) (totaling approximately 750 cubic yards [yd^3] of soil removed) and disposed offsite in 1987 (Malcolm Pirnie, May 1988). Following the removal action, this area of the storage yard was paved.

The RI/FS (ESE, May 1996a) for this site revealed that the soil was contaminated with total petroleum hydrocarbons (TPH), VOCs, and pesticides. In addition, VOC contamination was found in the groundwater beneath the site and outside the site boundary. The shallow groundwater beneath the hazardous materials area and the northern portion of the petroleum products area was impacted the most. Several VOCs were detected in one deep well (DW-1) at very low concentrations and found at higher concentrations in the shallower nested well. This may be due to the lack of a confining layer between the two aquifers in this area. None of the VOCs for which VDEQ nonpublic water supply standards had been established were exceeded in the deep well. The general extent of the groundwater plume, which affects approximately 29 acres beneath the fleet parking area west of the site, has been defined with monitoring-well and direct-push groundwater sampling. As a result of the delineation, the Q-Area has been subdivided into AOC 1 and AOC 2 (**Figure 6-1**) to reflect two distinct plumes consisting of high concentrations of VOCs.

A human health and ecological evaluation was conducted at Site 3. The human health evaluation identified VOCs in groundwater as presenting an unacceptable risk. The ecological screening evaluation did not identify any receptors under current and foreseeable future scenarios as a result of the site being a paved parking lot.

6.3 Site 3 Remedial Actions

6.3.1 Remedy Selection

The PRAP was issued in 1996 and the DD was signed in November 1996 to treat groundwater at the site (ESE, November 1996b). The DD identified the risks to human health and the environment, established the RAO, and defined the selected remedy. The

selected remedy for Site 3 includes remediation of the groundwater using AS/SVE, LTM, and LUCs to meet the following RAO:

- Minimize the threat of exposure to the contaminated groundwater through inhalation of VOCs by a potential human receptor (site worker and resident) in future buildings.

There was no additional action taken to treat the soil at Site 3 because the inorganic compounds appear to be inherited from the dredged material; Site 3 is not conducive to an ecological environment because it is a highly industrial area and is mostly a paved parking lot; and the present plans are for the unpaved area to be paved, which will subsequently eliminate the ecological risk pathway (ESE, November 1996b).

The DD selected the following LUCs for Site 3:

- Prohibit residential development on the site.
- Prohibit use of the shallow aquifer groundwater beneath the site for use as a potable water source.

The LUC restrictions have been implemented as detailed in the RD for LUCs at Site 3 (CH2M HILL, April 2007d). The LUC shall be maintained on all land within the boundaries of QADSY (**Figures 6-1**) until the concentrations of hazardous substances in the groundwater have been reduced to levels to allow for unlimited used and unrestricted exposure.

6.3.2 Remedy Implementation

A pilot treatability study was performed, the system was constructed, and the AS/SVE remediation system began operation in August 1998. Separate systems were installed to treat the two distinct plumes of VOCs (AOC 1 and AOC 2) that exceeded cleanup goals (**Table 6-1**). The AS/SVE system for AOC 1 consists of 30 AS wells and 14 SVE wells and the system for AOC 2 consists of 20 AS wells and 10 SVE wells. The AS/SVE systems for AOC 1 and AOC 2 are shown in **Figure 6-1**.

Before the AS/SVE remediation system started, monitoring wells were sampled in February 1998 and in May 1998 to provide baseline VOC and water-quality data. Subsequent to system operation, groundwater samples were collected at monitoring wells biannually. Monitoring well CMW-103 was paved over during parking lot repair activities and monitoring well SW-2 was buried in a dirt parking lot. Both monitoring wells were replaced in 2002 as CMW-103R and SW-2R, respectively. Sampling continues at Site 3 biannually at monitoring wells that have been retained in the LTM program.

Based on a substantial decrease of VOC concentrations during the first years of operation, the systems at AOC 1 and AOC 2 were modified in September 1999. The SVE system was shut off and the operation of the AS system was altered to a two-week cycle of pulse pumping.

6.3.3 System Operation and Maintenance

The standard O&M of the AS/SVE system is documented in the *Environmental Facility User Manual for Groundwater Remediation* (OHM, August 1998b). The maintenance associated with

the operation of the AS/SVE system is minimal and consists of weekly site visits and system monitoring. An unexpected maintenance issue arose when a 2-inch AS header pipe was damaged by a contractor performing intrusive work unrelated to Site 3. The system was shut down on July 20, 2007. Repairs were completed as soon as possible and the system began operating again on August 2, 2007.

The RPO Team continually evaluates the operations and maintenance of the AS/SVE system, including operating costs, and makes adjustments as appropriate to increase system efficiency. The findings have lead to the current closeout strategies developed and being implemented for each AOC and are discussed in greater detail in Section 6.4, Site 3 Technical Assessment.

6.4 Site 3 Progress Since Last Review

The previous Five-Year Review found the AS/SVE system at the QADSY to be protective of human health and the environment; however, an enhancement of the remediation system was being considered to treat a localized area with increased VC concentrations (CH2M HILL, October 2003).

Since the previous Five-Year Review, site inspections have been completed quarterly to verify the integrity of the site and operating system and groundwater sampling has been completed biannually to support the LTM program. The close-out strategy identified for AOC 1 in the 2003 Five-Year Review has been implemented and the AS/SVE system for this portion of the site has been shut down. Additionally, the closeout strategy for AOC 2 has been defined. The closeout strategies for AOC 1 and AOC 2 are detailed in Section 6.5.1, Long-Term Monitoring Review.

The shallow aquifer cleanup goals detailed in the DD were risk-based values for non-potable use. However in November 2007, the NSN Tier I Partnering Team came to an agreement to revise the groundwater cleanup goals from the risk-based values to MCLs for VOCs in the shallow aquifer (**Table 6-1**). An Explanation of Significant Difference (ESD) is currently being prepared to detail this DD cleanup goal revision.

6.5 Site 3 Five-Year Review Process

6.5.1 Long-term Monitoring Data Review

The LTM program was implemented as a requirement in the DD (ESE, 1996b) for Site 3 to evaluate the effectiveness of the remedial action. Baseline groundwater samples were collected in February and May 1998 and the LTM program at Site 3 began in 1999. LTM groundwater samples are collected biannually and analyzed for TCL VOCs. Additionally, select natural attenuation parameters were collected at Site 3 during the August 2007 sampling event to provide additional lines of evidence for the closeout strategies.

Initial sampling at Site 3 was completed at 14 monitoring wells (six monitoring wells at AOC 1 and eight monitoring wells at AOC 2). As part of the closeout strategy, when VOC concentrations in a monitoring well are consistently below the cleanup goals identified in the DD, and following NSN Tier I Partnering Team Consensus, the monitoring well is removed

from the LTM program. There were two monitoring wells in AOC 1 and eight monitoring wells in AOC 2 remaining in the LTM program during the 2007 sampling events. However, following the evaluation of the 2007 data, four additional wells were eliminated from the LTM program at AOC 2.

A summary of the data for AOC 1 and AOC 2 through 2007 is provided below. The first two and last two rounds of biannual sampling for each sampling location at AOC 1 and AOC 2 are shown on **Figures 6-2 and 6-3**, respectively.

AOC 1. In July 2002, the NSN Tier I Partnering Team agreed to a close-out strategy for AOC 1. The close-out strategy included the accelerated remediation proximal to CMW-101 since it was the only monitoring well with COC detections, specifically VC, that repeatedly exceeded its MCL. The accelerated remediation was accomplished by the extension of the treatment system via installation of a new AS well proximal to well CMW-101 followed by continued monitoring, and ultimately the shut down and dismantling of the system. The close-out strategy was implemented on April 4, 2003 when the new AS well began operation. Following the installation of the new AS well, four rounds of monitoring data were collected and showed that the concentrations of VC in well CMW-101 decreased to below the detection limit (February 2005). In accordance with the close-out strategy for the site, the air sparge system was shut down in June 2005. Initial sampling following shutdown of the system (August 2005) indicated concentrations of VC remained below the MCL at CMW-101 and CMW-103R. Subsequent monitoring events have reflected VC concentrations above the MCL at CMW-101, but at or below MCLs at CMW-103R. Therefore, the NSN Tier I Partnering Team agreed to remove monitoring well CMW-103R from the LTM program once the ESD is completed. An ESD is to be prepared to document the change in the cleanup goals to MCLs, the dismantling of the AS/SVE system as it is no longer considered effective at addressing the low concentrations of VOCs that remain, and to consider a more aggressive localized in situ treatment in the vicinity of CMW-101.

AOC 2. The close-out strategy for AOC 2, initiated in June 2006, consists of the addition of one new air sparge well to extend the treatment proximal to well CMW-202. In the last two rounds of sampling since the implementation of the close-out strategy, only two monitoring wells (CMW-201 and CMW-202) had VOCs detected at concentrations exceeding MCLs. At monitoring well CMW-201 there were five VOCs detected at concentrations exceeding their respective MCL and at CMW-202, only TCE exceeded the MCL.

In accordance with the close-out strategy for AOC 2, and following NSN Tier I Partnering Team agreement, the LTM program will be reduced to monitor only those wells that have had concentrations that have exceeded the cleanup goals. The remaining wells will be removed from the monitoring program based on VOC concentrations consistently less than the MCLs. The LTM data will continue to be evaluated to determine path forward based on the approved close-out strategy.

The eight monitoring wells included in the sampling plan at AOC 2 during the biannual 2007 sampling events are CMW-201, CMW-202, CMW-205S, CMW-205D, CMW-206S, CMW-206D, SW-9, and SW-10 (**Figure 6-3**). In general, COC concentrations have decreased over time and COC concentrations were below their respective MCL concentrations in six of the eight wells sampled during the 2007 biannual sampling events.

6.5.2 Site Inspections

Site inspections have been conducted at Site 3 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review.

No discrepancies have been observed at Site 3 during any of the quarterly inspections. An electrical substation has been installed adjacent to Site 3. However, construction of the electrical substation was completed in accordance with the requirements of the IRP and no issues were identified. The most recent inspection was conducted in February 2008 and no discrepancies were noted. Photographs taken during the February 2008 site inspections are included in **Appendix A**.

6.5.3 Site Interviews

An interview with the O&M contractor was conducted on May 1, 2008. An unexpected maintenance issue arose when a 2-inch AS header pipe was damaged by a contractor performing intrusive work unrelated to Site 3. The system was shut down on July 20, 2007. Repairs were completed as soon as possible and the system began operating again on August 2, 2007. The system is working effectively and VOC concentrations are decreasing. System optimization, as detailed in the closeout strategy for each AOC, is being implemented. Details of the Site 3 interview are provided in **Appendix B**.

6.6 Site 3 Technical Assessment

Is the remedy functioning as intended by the DDs?

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates the remedy is functioning as intended by the DD. The ICs that are in place include prohibitions on residential development and the use of groundwater at the site.

Based on the significant reduction of VOC concentrations during the first year of operation, the system operation was modified in September 1999. The SVE system was shut off and the operation of the AS system was altered to a 2-week cycle of pulsing. As intended, operation of the AS system has resulted in decreasing concentrations of VOCs. Accordingly, a closeout strategy for each AOC has been developed.

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-Year Review. As the cleanup goals were originally developed as risk-based values and are being revised the MCLs per an ESD on the DD, there is a potential additional evaluation of the ARARs that may be required.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review. There is no indication

that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 3, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the RA or the classes of constituents identified as COCs.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 3. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

Cleanup goals were established for the site based on risk scenarios; however, the NSN Tier I Partnering Team has agreed to change the site cleanup goals to the MCLs, which are protective of potable use of groundwater. As ICs are also in place, there is no current exposure to groundwater that is still present at the site at concentrations above MCLs. Any RA methodology changes would not affect the use of MCLs as the cleanup goals, and therefore would not affect the remedy. Furthermore there is an overall decreasing trend in concentrations based on the effective remediation.

Residential use of groundwater was not evaluated in the HHRA as it was considered an incomplete pathway. It is current practice to evaluate future residential use of groundwater, even though it may not be a likely future scenario, as an evaluation of unrestricted site use. However, evaluation of this scenario would not change the effectiveness of the remedy, as ICs are in place and they prevent use of and exposure to the groundwater at Site 3, and the revised Remedial Goal Objectives (RGOs) are MCLs, which are meant to be protective for potable use of groundwater.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy. Based on the LTM analytical data, the AS system at Site 3 has resulted in an overall decrease in VOC concentrations in the source areas. Therefore, the remedy is functioning as intended and a close-out strategy for the site has been established.

6.7 Site 3 Issues Identified

There were no issues identified at Site 3 during this Five-Year Review.

6.8 Site 3 Recommendations and Follow-up Actions

There are no recommendations or follow-up actions identified for the remedy at Site 3.

6.9 Site 3 Protectiveness Statement

The remedy at Site 3 consisting of the AS/SVE system is currently protective of human health and the environment and is expected to be protective in the future. The site groundwater concentrations are approaching the MCLs which has resulted in implementation of a closeout strategy. The exposure pathways that could result in unacceptable risks are being controlled through a combination of the groundwater treatment system, LUCs, and the implementation of ICs. Long-term protectiveness of the remedial action will be verified by continuing the LTM program until the cleanup levels have been achieved.

Table 6-1
Cleanup Goals for Groundwater at Site 3
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

Contaminant of Concern	Original Cleanup Goals (µg/L) Risk-based	Revised Cleanup Goals (µg/L)[a] MCL
Carbon Tetrachloride	2.7	5
Chloroform	11	80
1,1-Dichloroethene	0.38	7
Tetrachloroethene	60	5
Trichloroethene	49	5
Vinyl chloride	0.08	2

Notes:

[a] In November 2007, the NSN Tier 1 Partnering Team agreed to revise the groundwater cleanup goals from the risk-based values to MCLs for the shallow aquifer pending the approval of an Explanation of Significant Difference.

\\aphrodite\proj v:\18gis\nsn\figures\aoc1_aoc2.apr 2/24/08 MUnwin

LEGEND

- Air Sparge Well
- Soil Vapor Extraction Well
- Piping for AS/SVE Systems
- Land Use Control Area
- Monitoring Well
- Shallow Aquifer Groundwater Plume
- Direction of Groundwater Flow (January 1993)

February 2005 Aerial Photography

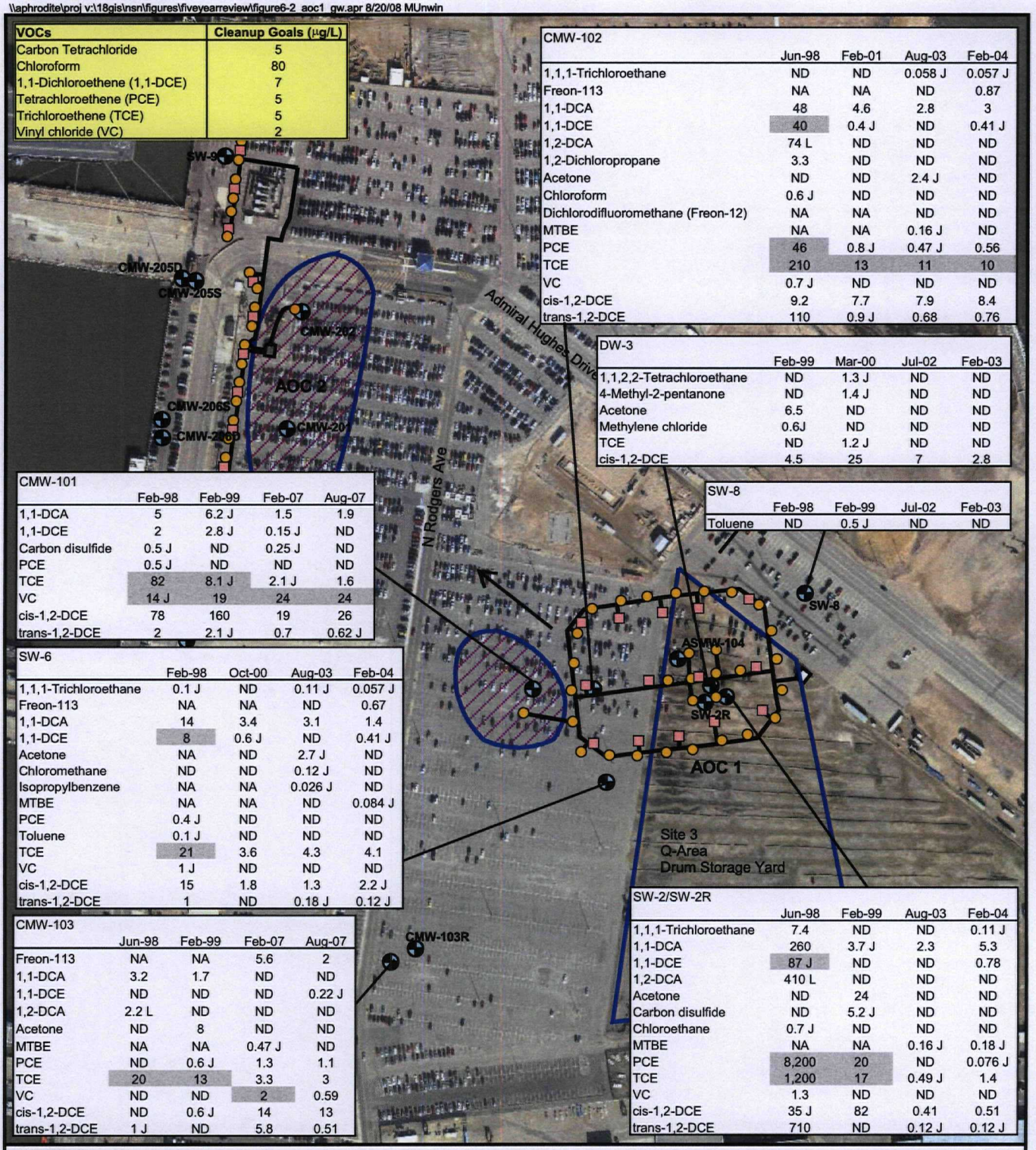
N

0 125 250 Feet

Figure 6-1
Site 3 - AOC 1 and AOC 2
AS/SVE Treatment System
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\fiveyearreview\figure6-2_aoc1_gw.apr 8/20/08 MUnwin



VOCs	Cleanup Goals (µg/L)
Carbon Tetrachloride	5
Chloroform	80
1,1-Dichloroethene (1,1-DCE)	7
Tetrachloroethene (PCE)	5
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

CMW-102

	Jun-98	Feb-01	Aug-03	Feb-04
1,1,1-Trichloroethane	ND	ND	0.058 J	0.057 J
Freon-113	NA	NA	ND	0.87
1,1-DCA	48	4.6	2.8	3
1,1-DCE	40	0.4 J	ND	0.41 J
1,2-DCA	74 L	ND	ND	ND
1,2-Dichloropropane	3.3	ND	ND	ND
Acetone	ND	ND	2.4 J	ND
Chloroform	0.6 J	ND	ND	ND
Dichlorodifluoromethane (Freon-12)	NA	NA	ND	ND
MTBE	NA	NA	0.16 J	ND
PCE	46	0.8 J	0.47 J	0.56
TCE	210	13	11	10
VC	0.7 J	ND	ND	ND
cis-1,2-DCE	9.2	7.7	7.9	8.4
trans-1,2-DCE	110	0.9 J	0.68	0.76

DW-3

	Feb-99	Mar-00	Jul-02	Feb-03
1,1,2,2-Tetrachloroethane	ND	1.3 J	ND	ND
4-Methyl-2-pentanone	ND	1.4 J	ND	ND
Acetone	6.5	ND	ND	ND
Methylene chloride	0.6J	ND	ND	ND
TCE	ND	1.2 J	ND	ND
cis-1,2-DCE	4.5	25	7	2.8

CMW-101

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	5	6.2 J	1.5	1.9
1,1-DCE	2	2.8 J	0.15 J	ND
Carbon disulfide	0.5 J	ND	0.25 J	ND
PCE	0.5 J	ND	ND	ND
TCE	82	8.1 J	2.1 J	1.6
VC	14 J	19	24	24
cis-1,2-DCE	78	160	19	26
trans-1,2-DCE	2	2.1 J	0.7	0.62 J

SW-8

	Feb-98	Feb-99	Jul-02	Feb-03
Toluene	ND	0.5 J	ND	ND

SW-6

	Feb-98	Oct-00	Aug-03	Feb-04
1,1,1-Trichloroethane	0.1 J	ND	0.11 J	0.057 J
Freon-113	NA	NA	ND	0.67
1,1-DCA	14	3.4	3.1	1.4
1,1-DCE	8	0.6 J	ND	0.41 J
Acetone	NA	ND	2.7 J	ND
Chloromethane	ND	ND	0.12 J	ND
Isopropylbenzene	NA	NA	0.026 J	ND
MTBE	NA	NA	ND	0.084 J
PCE	0.4 J	ND	ND	ND
Toluene	0.1 J	ND	ND	ND
TCE	21	3.6	4.3	4.1
VC	1 J	ND	ND	ND
cis-1,2-DCE	15	1.8	1.3	2.2 J
trans-1,2-DCE	1	ND	0.18 J	0.12 J

CMW-103

	Jun-98	Feb-99	Feb-07	Aug-07
Freon-113	NA	NA	5.6	2
1,1-DCA	3.2	1.7	ND	ND
1,1-DCE	ND	ND	ND	0.22 J
1,2-DCA	2.2 L	ND	ND	ND
Acetone	ND	8	ND	ND
MTBE	NA	NA	0.47 J	ND
PCE	ND	0.6 J	1.3	1.1
TCE	20	13	3.3	3
VC	ND	ND	2	0.59
cis-1,2-DCE	ND	0.6 J	14	13
trans-1,2-DCE	1 J	ND	5.8	0.51

SW-2/SW-2R

	Jun-98	Feb-99	Aug-03	Feb-04
1,1,1-Trichloroethane	7.4	ND	ND	0.11 J
1,1-DCA	260	3.7 J	2.3	5.3
1,1-DCE	87 J	ND	ND	0.78
1,2-DCA	410 L	ND	ND	ND
Acetone	ND	24	ND	ND
Carbon disulfide	ND	5.2 J	ND	ND
Chloroethane	0.7 J	ND	ND	ND
MTBE	NA	NA	0.16 J	0.18 J
PCE	8,200	20	ND	0.076 J
TCE	1,200	17	0.49 J	1.4
VC	1.3	ND	ND	ND
cis-1,2-DCE	35 J	82	0.41	0.51
trans-1,2-DCE	710	ND	0.12 J	0.12 J

LEGEND

- Monitoring Well
- Shallow Aquifer Groundwater Plume
- Land Use Control Area
- Air Sparge Well
- Soil Vapor Extraction Well
- Piping for AS/SVE Systems

← Direction of Groundwater Flow (January 1993)

ND - Not detected
J - Reported value is estimated
L - Analyte present; reported value is biased low
"R" in the well identification denotes a replacement well installed in 2002
DCE - Dichloroethene
DCA - Dichloroethane
MTBE - Methyl-tert-butyl ether

N

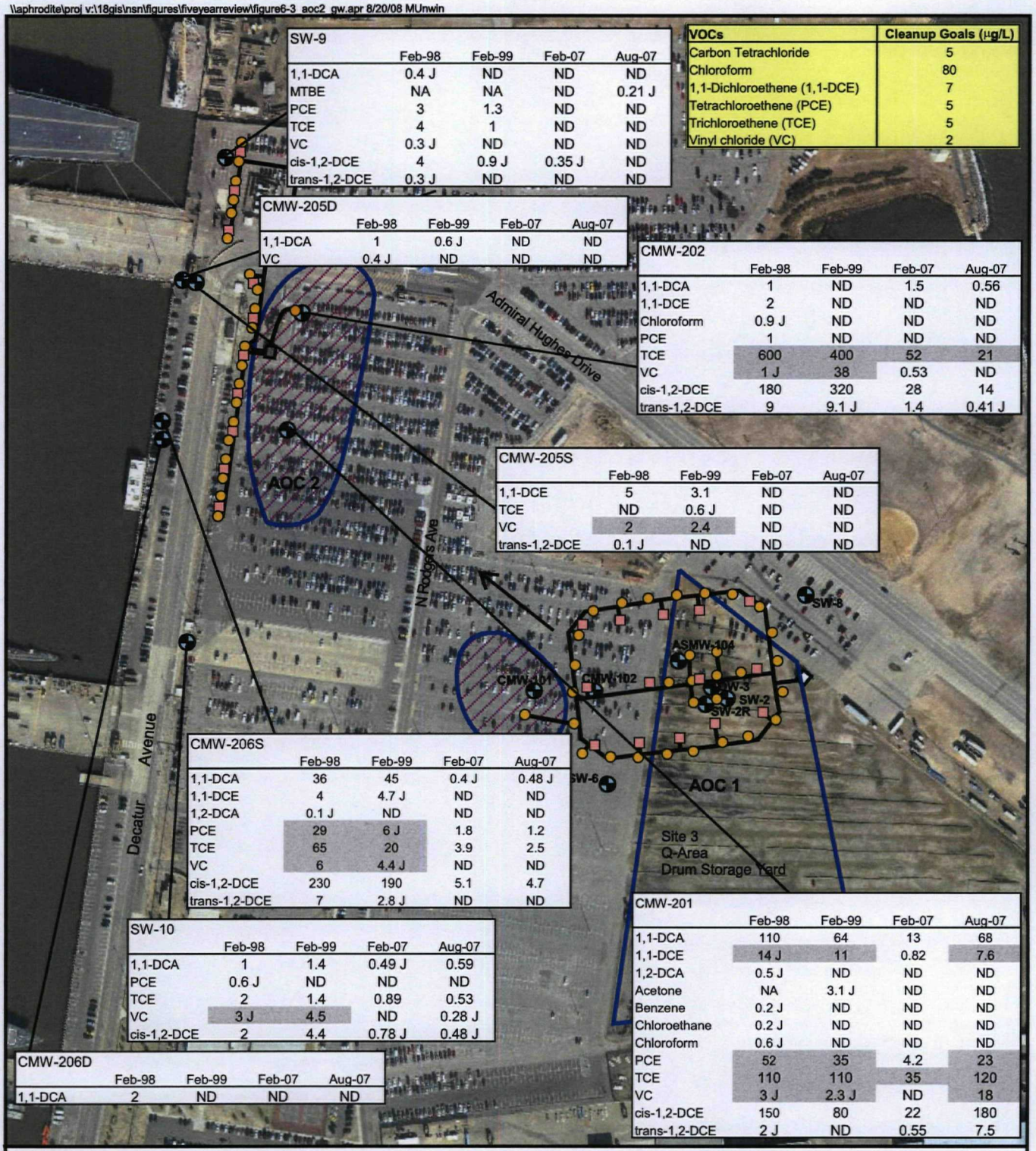
0 150 300 Feet

Note:
Units are in micrograms per liter (µg/L).
The detected concentration values that exceed cleanup goals are highlighted.
This figure only shows the detected VOCs from the first two and last two rounds of biannual sampling at each sampling location.
February 2005 Aerial Photography

Figure 6-2
Site 3 - AOC 1, VOCs in Groundwater
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\fiveyearreview\figure6-3_aoc2_gw.apr 8/20/08 MUnwin



VOCs	Cleanup Goals (µg/L)
Carbon Tetrachloride	5
Chloroform	80
1,1-Dichloroethene (1,1-DCE)	7
Tetrachloroethene (PCE)	5
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

SW-9

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	0.4 J	ND	ND	ND
MTBE	NA	NA	ND	0.21 J
PCE	3	1.3	ND	ND
TCE	4	1	ND	ND
VC	0.3 J	ND	ND	ND
cis-1,2-DCE	4	0.9 J	0.35 J	ND
trans-1,2-DCE	0.3 J	ND	ND	ND

CMW-205D

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	1	0.6 J	ND	ND
VC	0.4 J	ND	ND	ND

CMW-202

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	1	ND	1.5	0.56
1,1-DCE	2	ND	ND	ND
Chloroform	0.9 J	ND	ND	ND
PCE	1	ND	ND	ND
TCE	600	400	52	21
VC	1 J	38	0.53	ND
cis-1,2-DCE	180	320	28	14
trans-1,2-DCE	9	9.1 J	1.4	0.41 J

CMW-205S

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCE	5	3.1	ND	ND
TCE	ND	0.6 J	ND	ND
VC	2	2.4	ND	ND
trans-1,2-DCE	0.1 J	ND	ND	ND

CMW-206S

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	36	45	0.4 J	0.48 J
1,1-DCE	4	4.7 J	ND	ND
1,2-DCA	0.1 J	ND	ND	ND
PCE	29	6 J	1.8	1.2
TCE	65	20	3.9	2.5
VC	6	4.4 J	ND	ND
cis-1,2-DCE	230	190	5.1	4.7
trans-1,2-DCE	7	2.8 J	ND	ND

SW-10

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	1	1.4	0.49 J	0.59
PCE	0.6 J	ND	ND	ND
TCE	2	1.4	0.89	0.53
VC	3 J	4.5	ND	0.28 J
cis-1,2-DCE	2	4.4	0.78 J	0.48 J

CMW-206D

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	2	ND	ND	ND

CMW-201

	Feb-98	Feb-99	Feb-07	Aug-07
1,1-DCA	110	64	13	68
1,1-DCE	14 J	11	0.82	7.6
1,2-DCA	0.5 J	ND	ND	ND
Acetone	NA	3.1 J	ND	ND
Benzene	0.2 J	ND	ND	ND
Chloroethane	0.2 J	ND	ND	ND
Chloroform	0.6 J	ND	ND	ND
PCE	52	35	4.2	23
TCE	110	110	35	120
VC	3 J	2.3 J	ND	18
cis-1,2-DCE	150	80	22	180
trans-1,2-DCE	2 J	ND	0.55	7.5

LEGEND

- Monitoring Well
- Shallow Aquifer Groundwater Plume
- Land Use Control Area
- Air Sparge Well
- Soil Vapor Extraction Well
- Piping for AS/SVE Systems

← Direction of Groundwater Flow (January 1993)

ND - Not detected
J - Reported value is estimated
DCE - Dichloroethene
DCA - Dichloroethane
MTBE - Methyl-tert-butyl ether

N

0 150 300 Feet

Note:
Units are in micrograms per liter (µg/L).
The detected concentration values that exceed cleanup goals are highlighted.
This figure only shows the detected VOCs from the first two and last two rounds of biannual sampling at each sampling location.
February 2005 Aerial Photography

Figure 6-3
Site 3 - AOC 2, VOCs in Groundwater
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 7

Site 6—CD Landfill

7.1 Site 6 Chronology

Below is the chronology of the major site events for Site 6, CD Landfill.

1974-1979	Disposal of material in the unpermitted (eastern) section of the landfill
October 1979	Virginia Department of Health (VDOH) issued a permit for disposal of demolition debris and non-putrescible wastes at the site
1979-1987	Disposal of material in the permitted (western) section of the landfill
1983	CD Landfill identified as a potential source of contamination in the IAS
1991	Site Investigation (SI) completed
1993	Seabee Road was constructed over the site
1995	RI completed
July 1996	FS completed
October 1996	PRAP completed and Decision Document signed for site sediment Operable Unit (OU) 1
April 1997	NSN placed on the NPL
1997	Removal of contaminated sediments
1998	PRAP completed and ROD signed for site soil and groundwater (OU2)
December 1999	Construction of the landfill cap was completed
December 1999	Post-closure Plan was completed
2000-2001	Quarterly groundwater and surface water monitoring conducted
March 2001	Annual Post-closure Monitoring Report completed
February 2002	Annual Post-closure Monitoring Report completed
February 2003	Annual Post-closure Monitoring Report completed
October 2003	Implementation of Five-Year Review process
February 2004	Annual Post-closure Monitoring Report completed
March 2004	First Determination Report completed. LTM Phase II monitoring discontinued and LTM Phase I monitoring reinstated per recommendations from the First Determination Report

February 2005	Annual Post-closure Monitoring Report completed
February 2006	Annual Post-closure Monitoring Report completed
March 2007	VSWMR Groundwater Management Report completed
January 2007	RD finalized
February 2008	LTM Site 6 Tech Memo completed to document 2007 sampling

7.2 Site 6 Background

Site 6, the CD Landfill, occupies approximately 22 acres located in the central portion of NSN just east of Hampton Boulevard and south of the Naval Exchange, as illustrated in (**Figure 2-1**). The site incorporates two areas of landfilling operations; the easternmost (unpermitted) section and the western (permitted) section (**Figure 7-1**). The unpermitted portion operated from 1974 to 1979 and was used for demolition debris, inert solid waste, fly ash, and incinerator residue (CH2M HILL, February 2002).

In October 1979, the Naval Facilities Engineering Command received a permit from VDOH to use the landfill (western portion) for disposal of demolition debris and other non-putrescible wastes, excluding fly ash, incinerator residues, chemicals, and asbestos. Blasting grit used for sandblasting cadmium-plated aircraft parts was deposited at the landfill until 1981 when the blasting grit was tested and found to exceed the USEPA Extraction Procedure (EP) toxicity limit for cadmium. The grit was classified as a hazardous waste and onsite disposal of the material ceased. Landfilling operations continued in the site's western portion of the site. At the time the landfill permit was granted, a portion of the site's southeastern corner was removed and regraded to allow for runway expansion at the Naval Air Station (NAS). The runway expansion design specified that excess material was to be spread over the landfill and not removed from the site.

In 1993, Seabee Road was constructed over the site and opened to the public. Construction plans required only the addition of fill material; no cutting or grading into the existing landfill occurred. Most of the existing debris mounds situated in the north-central portion of the landfill were leveled and spread around the site to reduce the amount of standing water that accumulated after rain events. The two drainage ditches were constructed to facilitate runoff of surface water (eventually flowing into Bousch Creek) from the landfill area (Baker, 1998b). Presently, Site 6 is not utilized for any land or resource uses, nor anticipated to change in the near future. Two fences encompass the eastern and western portions of the landfill and along Seabee Road.

The CERCLA investigated surficial geology at Site 6 consists of the Columbia Aquifer, Yorktown confining unit, and the Yorktown Aquifer. The Columbia and Yorktown Aquifers are not used for beneficial use within the vicinity or downgradient of Site 6. The water table is encountered approximately 4 to 6 ft bgs in the unconfined Columbia aquifer (Baker, September 1998b). The groundwater flow in the surficial aquifer within the vicinity of Site 6 is varies across the site and is shown on **Figure 7-1**.

Site 6 was first identified as an area of potential contamination in the IAS. A confirmation study, Environmental SI (ESI), Limited Soils Study guided the scope of the RI completed in

1994. The RI was conducted in three separate rounds of sampling. During each round of sampling, soil, sediment, groundwater, and surface water samples were collected. As a result of the RI/RA Report, an FS was prepared in July 1996 to address contaminated media at the CD Landfill site. Potential risks to ecological and human health risk associated with contaminants in the soil, sediments, groundwater, and surface water were identified and guided the development and evaluation of the media-specific remedial action alternatives. In addition to the FS, a separate geostatistical analysis was performed to evaluate and better define the areas of sediment contamination.

The RI (Baker, December 1995d) analysis concluded the landfill activities had impacted the surface soil, subsurface soil, sediment, surface water, and shallow groundwater. The COCs per media are summarized below:

- **Soil**—prevalent constituents include arsenic, beryllium, lead, and manganese. Constituents detects at significant levels are antimony, cadmium, chromium, copper, nickel, vanadium, and zinc
- **Shallow groundwater**—One organic compound (chlorobenzene) and several metals including arsenic, beryllium, chromium, lead, and manganese
- **Surface water**—1,4-dichlorobenzene, lead, and arsenic
- **Sediment**—acetone, chlorobenzene, polynuclear aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs)

In June 1997, the NSN Tier I Partnering Team agreed to an additional sampling event to characterize the landfill material and determine closure requirements. A statistical sampling approach was developed to determine within a specified confidence interval whether the fill material would be classified as hazardous. All of the samples collected and analyzed during the June event were below the regulatory standards. Based on the statistical findings, the fill material at the CD Landfill is not considered a hazardous waste and it was agreed that the site would be closed under the VSWMR for a construction demolition debris landfill.

7.3 Site 6 Remedial Actions

7.3.1 Remedy Selection

A DD was issued for contaminated sediments (OU 1) at the CD Landfill in October 1996 (Baker, 1996d) to reduce the risk to human and ecological receptors. A NTCRA was implemented in the fall of 1997 for the removal and off-site disposal of contaminated sediments that exceeded the Effect-Range Median (ERM) levels. As shown in **Figure 7-1**, a partial removal of the contaminated sediments was conducted. The remaining sediments were covered during the construction of CD Landfill cap for Site 6.

A PRAP (Baker, June 1998a) and ROD (Baker, 1998b) for Site 6 were issued to address the soil and groundwater (OU2) and to extend the cover over the remaining sediment area that was not completed for OU1 (**Figure 7-1**). The purpose of the remedial action was to reduce hazards to human health and the environment by eliminating exposure to contaminated media. The selected remedy includes a landfill cap, monitoring program, restricted access to the site, and ICs prohibiting future land and resource uses.

The selected remedies for OU1 and OU2 were implemented to meet the following RAOs:

- Prevent exposure to contaminated sediment by human and ecological receptors.
- Prevent exposure to contamination within the subsurface soil and debris.
- Minimize potential movement of contaminants from soil and debris to groundwater and surface water.
- Minimize direct ecological exposure to the surface soils.
- Prevent potable and non-potable exposure to the shallow groundwater by human receptors.
- Prevent Yorktown aquifer groundwater use for potable purposes.
- Monitor migration of shallow groundwater towards site boundaries and for discharge to surface water.

The DD for OU 1 and the ROD for OU2 selected the following LUC objectives at Site 6:

OU1

- Prohibiting residential use of the area.
- Prohibit invasive construction activities in the drainage ditch.

OU2

- Prohibit residential development of the site.
- Prohibit use of the shallow aquifer groundwater beneath the site other than for environmental monitoring and testing.
- Prohibit public access to the site.
- Prohibit any action that would disturb the integrity of the existing landfill cover or function of the monitoring systems.

The LUCs have been implemented and maintained on all land and groundwater within the boundaries of Site 6. The LUCs shall be maintained on all media by the Navy until the concentrations of hazardous substances in the sediment, subsurface soil, landfill debris, and groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure.

7.3.2 Remedy Implementation

The remedial actions completed at Site 6 are summarized below:

- Partial removal and offsite disposal of sediments in the former drainage ditch occurred in the fall of 1997.
- A geomembrane landfill cap was designed, constructed, and maintained to VSWMR.
- LUCs are maintained as defined in the RD to prevent migration of contaminants and potential exposure to receptors.

As outlined in the *Landfill Closure Certification Report* (CH2M HILL, August 2000a), construction of the CD Landfill cap was initiated in May 1999 and completed in June 2000. The cap's extent is illustrated in **Figure 7-1**. Construction began with a final grading of the waste and installation of a 6-inch bedding layer to support the cover material. Following placement of the bedding layer, an impermeable barrier membrane was installed to prevent infiltration of water into the landfill material. A geocomposite drainage layer was also placed to provide adequate drainage of the cover and prevent water pressure from causing slope stability problems. The drainage layer is covered with a minimum of 24 inches of soil. This soil layer consists of 18 inches of onsite material overlain by 6 inches of topsoil to provide adequate nutrients to support the vegetation necessary to prevent erosion of the landfill cover. No venting systems were needed according to the investigation performed in the *Basis of Design for the Landfill Cap CD Landfill* (CH2M HILL/Baker/CDM, October 1998).

7.3.3 System Operation and Maintenance

O&M at the site consists of periodic mowing of the vegetative cover as well as inspections of the landfill cover and ICs. Quarterly inspections are conducted to ensure the landfill cover, fences, and gates are maintained as defined in the RD.

As a requirement of the VSWMR, Part D of 9 VAC 20-80-270, the CD Landfill is currently part of the LTM program at NSN. In 2000, quarterly groundwater samples were collected from seven monitoring wells at CD Landfill (MW01B, MW02B, MW03A, MW04A, MW05B, MW06B, and MW12A) in order to establish the site's background groundwater quality and groundwater flow direction. Groundwater samples were collected and analyzed for groundwater contamination indicator parameters (specific conductivity, pH, Total Organic Carbon [TOC], and Total Organic Halogens [TOX]) and groundwater quality parameters (chloride, hardness, iron, lead, and sodium). During each sampling event, four replicate measurements were collected in order to establish baseline data. In addition, MW05B and three surface water samples (SW01, SW02, and SW03) were sampled for 1,4-dichlorobenzene and chlorobenzene in all the sampling rounds.

During 2001, groundwater contamination indicator parameters and groundwater levels were sampled semiannually, and groundwater quality parameters annually at eight groundwater wells (MW01B, MW02B, MW03A, MW04A, MW05B, MW06B, MW11AR, and MW12A). In addition, MW05B and MW12A, as well as three surface water samples (SW01, SW02, and SW03), were sampled quarterly for 1,4-dichlorobenzene and chlorobenzene . MW11AR was installed (to replace damaged MW11A well) for inclusion in the 2001 sampling program. Replicate sampling of all parameters was conducted at replacement well MW11AR during each quarter of 2001 to establish background data. Surface water monitoring was ceased after analysis of the initial 2 years of sampling when COC levels dropped below screening criteria.

In 2002 and 2003, groundwater samples were collected semiannually and analyzed for groundwater contamination indicator parameters, groundwater quality parameters, and groundwater levels. In addition, based upon the trend of increasing indicator parameter concentrations at the downgradient monitoring wells (MW12A and MW05B), a Phase II sampling program was initiated in the shallow monitoring wells upgradient (MW01B and MW02B) and downgradient (MW05B and MW12A) of the landfill. The Phase II sampling consisted of analysis of an additional 15 inorganic and 47 organic constituents as detailed in

9 VAC 20-80-270. In October 2003, the VDEQ informed the partnering team the VSWMR (amended March, 2003) no longer requires groundwater quality parameters to be analyzed by the LTM program at Site 6. The Phase II results, analyzed in 2004 by the Shewart-CUSUM trend analysis, of the groundwater contamination indicator parameters demonstrated a relatively consistent trend over the sampling events performed thus far as indicated in the *First Determination Report to Site 6, CD Landfill* (CH2M HILL, March 2004b). Therefore, Phase II monitoring was discontinued and the Phase I monitoring was reinstated in 2004.

During the 2004 to 2006 monitoring events, semiannual groundwater samples were collected and analyzed for groundwater contamination indicator parameters and groundwater levels. The initial 6 years of monitoring and groundwater level analysis have been completed and documented in Annual Post-Closure Monitoring Reports in compliance with VSWMR. No Annual Post-Closure Monitoring Report was completed for the 2006 sampling pending a determination of the appropriate groundwater monitoring program.

In 2006, the VDEQ, USEPA, and the NAVY addressed concerns of the current groundwater monitoring program to meet the substantive requirements of the VSWMR based upon the groundwater results that had been collected and reported through 2005. As a result of this meeting, a *Groundwater Management Plan (GMP) for Site 6, CD Landfill* (CH2M HILL, March 2007a) was completed and implemented in March 2007. The GMP outlined groundwater monitoring that would be needed in order to complete a Corrective Action Site Evaluation (CASE) report in 2010. The new monitoring program includes monitoring of eight wells (MW01B, MW02B, MW03A, MW04A, MW05B, MW06B, MW11AR, and MW12A) on a quarterly basis for the first 2 years of monitoring, then semiannual monitoring for the third year. Ten rounds of data are required to ensure the dataset is of sufficient size for an evaluation that will be included in the CASE report.

7.4 Site 6 Progress since Last Review

The previous Five-Year Review deemed the remedy for Site 6, CD landfill, protective of human health and the environment. The issues and recommendations of the previous Five-Year Review have been addressed and site inspections have been performed quarterly by the Navy.

7.5 Site 6 Five-Year Review Process

7.5.1 Long-term Monitoring Data Review

The LTM program included sampling surface water and groundwater for 10 years following the implementation of the ROD. As a requirement of the VSWMR, Part D of 9 VAC 20-80-270, the CD Landfill is currently part of the LTM program at NSN, as described in the system maintenance and operation section (Site 6) of this report. Surface water monitoring was ceased after the first 2 years of sampling when COC levels dropped below screening criteria. The initial 6 years of groundwater monitoring have been completed and are documented in Annual Post-closure Monitoring Reports for each year.

In 2007, the *Groundwater Management Plan (GMP) for Site 6, CD Landfill* (CH2M HILL, March 2007a) was finalized to outline the establish a groundwater monitoring program that meets the substantive requirements of the corrective action groundwater monitoring program in accordance with VSWMR. As detailed in the GMP, monitoring at Site 6 includes sampling and analysis of eight monitoring wells, sampled quarterly for the first 2 years of monitoring, then semiannually for the third year. The first year of quarterly sampling began in March 2007. In accordance with the GMP, these samples were analyzed for the constituents listed in VSMWR Table 5.1. Of the constituents detected during the March 2007 event, only two constituents (dieldrin and mercury) are not included in VSWMR Table 5.5. Dieldrin was detected at an estimated value below the detection limit, and total mercury was detected at 1.1 µg/L in MW04. Dieldrin was inadvertently excluded in the remaining quarterly 2007 sampling events because the low estimated value was initially interpreted as non-detect. Therefore, in the remaining quarterly 2007 sampling events, each monitoring well was sampled for VSWMR Table 5.5 constituents plus mercury. Dieldrin will be re-evaluated in March 2008 sampling event to verify the detected concentration and determine the need for continued monitoring in the remaining sampling events as a detected Table 5.1 constituent. The concentrations of constituents detected in the 2007 sampling events are illustrated in **Figure 7-2** and the complete data set is provided in the *LTM Site 6, CD Landfill Tech Memo* (Agviq/CH2M HILL, February 2008a). Once 10 groundwater sampling events have been completed (2007 to 2009), groundwater data will be evaluated in accordance with the CASE report as detailed in the GMP (scheduled for 2010).

7.5.2 Site Inspections

Site inspections have been conducted at Site 6 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review.

In September 2006, an inspection was completed and identified that trees had been planted within the landfill along SeaBee Road and had impacted the integrity of the landfill cap. The landfill cap was repaired in October 2006 (Agviq/CH2M HILL, October 2006). The most recent inspection was conducted in February 2008 and no discrepancies were noted. Photographs taken during the February 2008 site inspections are included in **Appendix A.**

7.5.3 Site Interviews

There is no active system at Site 6 and consequently no operator responsible for system maintenance. Therefore, no interviews were needed for this site.

7.6 Site 6 Technical Assessment

Is the remedy functioning as intended by the DDs?

Upon review of historical documents, RAs, ARARs, site inspections, and LTM monitoring results, the remedy-in-place (RIP) is functioning as intended by the ROD(s). The stabilization and capping of the landfill and contaminated soil and sediments has achieved the RAOs to minimize migration of contaminants to surface water and groundwater. The ICs implemented have prevented exposure to groundwater by potential receptors.

In order to optimize the LTM at Site 6, a new GMP was drafted to meet the requirements of a corrective action groundwater monitoring program while demonstrating the effectiveness of the remedy and compliance with the groundwater protection standard. A statistical analysis will be performed on this data set to evaluate the migration of contaminants.

The ICs will continue to be implemented at the site to prohibit the use of groundwater and disturbance to the remedy until unlimited use and unrestricted exposure is achieved.

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affects the protectiveness of the remedy were identified during this Five-Year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although several changes in toxicity values, regulatory levels, and risk characteristics of some COCs at Site 6, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment.

Sediment cleanup goals were based on ecological criteria, which are lower than the human health risk-based levels. Since all sediments at Site 6 have been removed or capped, potential risk to ecological receptors has been minimized.

Changes in Risk Assessment Methodologies. Although few procedural changes to how a HHRA is conducted have been made, none of these changes adversely affect the protectiveness of the selected remedy for Site 6. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

The remedies for Site 6, removal of contaminated sediment, capping the landfill, and land use restrictions remain protective of human health.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the selected remedy.

7.7 Site 6 Issues Identified

Table 7-1 presents the issues that have been identified for Site 6 based on this Five-Year Review.

TABLE 7-1
Issues for Site 6
Naval Station Norfolk

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Trees within the landfill along SeaBee Road and had impacted the integrity of the landfill cap.	N	N

7.8 Site 6 Recommendations and Follow-up Actions

Table 7-2 presents recommendations and follow-up actions for Site 6.

TABLE 7-2
Recommendations and Follow-up Actions for Site 6
Naval Station Norfolk

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date	Affects Protectiveness (Y/N)	
				Current	Future
Trees within the landfill along SeaBee Road and had impacted the integrity of the landfill cap.	The landfill cap was repaired and documented in October, 2006. Continued improvement of the facility's site approval process prior to site disturbance is recommended.	Navy EPA VDEQ	Oct. 2006	N	N

7.9 Site 6 Protectiveness Statement

The landfill cap remedy at Site 6 prevents direct contact with the soil. Supporting inspection information and monitoring data indicate the landfill cap is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cap, LUCs, and the implementation of ICs.

\\aphrodite\proj v:\18gis\nsn\figures\five_year_review_sites.apr 2/26/08 MUnwin

LEGEND

- Monitoring Well
- Areas of Sediment Removal
- Soil Cap - Remedial System Caps/Covers
- Land Use Control Area
- Drainage Ditch
- Direction of Groundwater Flow (February 2005)

February 2005 Aerial Photography

N

0 200 400 Feet

Figure 7-1
Site 6 - CD Landfill
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\five_year_review_sites.apr 2/26/08 MUnwin

MW11AR	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
		no detections		
Pest/PCBs				
Dieldrin	0.0228 J	ND	ND	ND
Total Metals				
Antimony	ND	0.294 J	ND	ND
Arsenic	1.95	1.06	0.776 J	0.746 J
Barium	63.7	39.4	31.9	38.5
Cadmium	ND	0.313 J	0.132 J	0.137 J
Chromium	3.38	1.12 J	6.56	3.22
Cobalt	0.743 J	0.479 J	0.77 J	0.658 J
Copper	2.14	1.21 J	1.11 J	1.24 J
Lead	ND	ND	ND	4.8
Nickel	4.51	7.68	6.4	4.84
Selenium	ND	1.27	1.68	1.31
Thallium	0.0528 J	ND	0.293	ND
Vanadium	2.04	0.784 J	1.72	0.929 J
Zinc	5.26 J	30.4	ND	6.47 J

MW03A	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
		no detections		
Total Metals				
Antimony	ND	0.358 J	ND	0.311 J
Arsenic	2.07	1.91	4.59	6.39
Barium	49.3	49	50.5	50.1
Beryllium	ND	ND	0.505 J	ND
Cadmium	ND	ND	0.136 J	ND
Chromium	2.91	1.31 J	10.7	4.77
Cobalt	0.89 J	1.3	2.43	2
Copper	0.786 J	0.752 J	0.696 J	0.638 J
Lead	ND	ND	0.444 J	ND
Nickel	2.03 J	7.53	4.65	3.15 J
Selenium	ND	1.38	0.924 J	1.49
Thallium	ND	ND	0.392	0.081 J
Vanadium	1.19	0.444 J	2.65	1.09
Zinc	ND	ND	ND	6.5 J

MW04A	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
Acetone	3.71 J	5.65	ND	7.78
Total Metals				
Antimony	4.27	0.443 J	3.63	ND
Arsenic	29.7	5.61	39.6	5.75
Barium	317	217	339	212
Beryllium	ND	ND	0.742 J	ND
Cadmium	3.56	ND	1.23	0.279 J
Chromium	10	1.94 J	12.2	6.21
Cobalt	2.23	0.575 J	1.28	0.546 J
Copper	270	13.4	62	12.3
Lead	73.6	1.87	24.1	2.44
Mercury	1.1	ND	0.229	ND
Nickel	28.3	9.7	16.2	5.35
Selenium	4.61	12	11.2	17.2
Silver	1.41	ND	0.321 J	ND
Thallium	ND	ND	0.19 J	0.0843 J
Vanadium	12.1	1.17	6.45	2.05
Zinc	385	21.3	158	23.4

MW12A	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
		no detections		
Total Metals				
Arsenic	114	50.3	43.9	58.6
Barium	78.3	76.7	71.9	64.7
Beryllium	ND	ND	1.01 J	ND
Cadmium	ND	0.143 J	ND	ND
Chromium	4.59	3.22	2.14	4.52
Cobalt	0.889 J	0.775 J	0.987 J	0.958 J
Copper	0.502 J	0.537 J	0.579 J	0.785 J
Lead	0.298 J	ND	0.38 J	0.635 J
Nickel	1.26 J	3.58 J	2.46 J	2.05 J
Selenium	1.12	3.3	4.98	4.42
Thallium	0.051 J	0.0548 J	0.498	0.0785 J
Vanadium	3.13	1.51	1.07	3.21
Zinc	ND	ND	ND	7.98 J

MW05B	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
Acetone	ND	3.62 J	ND	ND
Total Metals				
Antimony	1.2	0.866 J	3.38	1.99
Arsenic	2.58	4.49	10.2	5.4
Barium	77.4	88.2	116	132
Cadmium	ND	0.153 J	ND	ND
Chromium	3.29	3.22	8.91	4.21
Cobalt	0.522 J	0.716 J	1.84	6.08
Copper	0.923 J	0.885 J	1.4 J	2.52
Lead	0.676 J	0.266 J	0.648 J	0.591 J
Nickel	3.2 J	9.45	10.6	16.9
Selenium	0.615	1.65	1.43	1.82
Thallium	0.124 J	ND	0.208	ND
Vanadium	1.82	1.86	2.92	1.87
Zinc	39.4	69.2	93.9	1,990

MW01B	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
Acetone	ND	5.75	ND	ND
Total Metals				
Antimony	ND	ND	0.34 J	ND
Arsenic	1.41	0.736 J	0.732 J	0.971 J
Barium	38.4	39.1	41.4	45.9
Beryllium	2.62 J	3.06 J	3.14 J	2.61 J
Cadmium	0.262 J	0.407 J	0.346 J	0.242 J
Chromium	2.79	0.622 J	1.63 J	2.85
Cobalt	27.3	39.1	38.4	28.9
Copper	2.24	2.49	3.08	1.39 J
Lead	ND	ND	0.339 J	0.767 J
Nickel	15.2	18.5	21.7	15.5
Selenium	1.24	1.31	2.11	2.69
Thallium	ND	ND	0.256	ND
Vanadium	0.824 J	ND	0.27 J	ND
Zinc	147	231	223	170

MW06B	Mar-07	Jun-07	Sep-07	Dec-07
VOCs				
Chloromethane	ND	ND	0.348 J	ND
Total Metals				
Arsenic	1.82	2.57	3.95	3.19
Barium	39.3	37.1	28.1	28.2
Chromium	1.52 J	2.63	2.36	4.19
Cobalt	ND	0.277 J	ND	0.373 J
Copper	ND	0.548 J	ND	0.924 J
Lead	ND	ND	ND	0.45 J
Nickel	1.04 J	2.95 J	2.03 J	1.77 J
Selenium	ND	0.723 J	0.615 J	0.977 J
Thallium	ND	ND	0.106 J	ND
Vanadium	0.95 J	1.53	1.36	2.18
Zinc	11.5 J	ND	ND	6.32 J

LEGEND

- Monitoring Well
- Areas of Sediment Removal
- Soil Cap - Remedial System Caps/Covers
- Land Use Control Area
- Drainage Ditch
- Direction of Groundwater Flow (February 2005)

February 2005 Aerial Photography
ND - Not detected
J - reported value is estimated
Units are in micrograms per liter (µg/L)

N

0 200 400 Feet

Figure 7-2
Site 6 - Detected Compounds in Groundwater
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 8

Site 20—Building LP-20

8.1 Site 20 Chronology

Below is the chronology of the major site events for Site 20, Building LP-20.

1940s-1990s	Numerous spills and releases documented in the area
Circa 1986	Product Recovery System #1 installed
Circa 1988-1990	Product Recovery System #2 installed
1991	Preliminary Assessment/SI (PA/SI) completed
December 1994	Product Recovery Systems shut down and dismantled
1995	RI/FS completed
1996	PRAP completed and DD signed
April 1997	NSN placed on the NPL
1997	Construction of the AS/SVE system
April 1998	Remediation system began operation
November 1998	Implementation of annual LTM
October 2003	Implementation of Five-Year Review process
April 2007	Final RD for LUCs at Site 20

8.2 Site 20 Background

The Site 20, Building LP-20, is located within the Naval Aviation Depot (NADEP) area of NSN (**Figures 2-1 and 8-1**). In general the NADEP area is highly developed and industrialized. The entire surface of Site 20 is relatively flat and paved with either asphalt or concrete. The only vegetation present in the area is in the landscaped zones located along roadways or parking areas. Groundwater flow varies across Site 20 and is shown in **Figure 8-1**. The water table is typically 5 to 7 ft bgs. The shallow subsurface in the area is an accumulation of nearshore, beach, and backbeach sediments consisting of medium to coarse sands, with silt and stringers of sandy, silty clay, and basal clay. The Columbia Aquifer is separated from the upper Yorktown Aquifer by a confining clay layer that extends from approximately 27 to 37 ft bgs.

Building LP-20 is one of many large buildings northwest of the NAS main runway (**Figure 8-1**). Currently, the building houses PWC's Transportation Department. In the past, a portion of the building was used for aircraft engine overhaul and maintenance. Previous activities at the building included painting, X-ray facilities, cleaning and blasting, and a

metal-plating operation. Waste products generated from these activities were transferred to the industrial wastewater treatment plant via underground piping. In addition, a large fuel storage area, known as LP fuel farm, is also located south of the building. An underground pipeline extends from the Fuel Farm to buildings LP-78 and LP-176 located east of the site. Over the years (1940s to 1990s), numerous spills or releases of wastewater and petroleum have been documented. Significant releases were associated with damage to underground wastewater lines during construction activities, and leakage of the underground petroleum pipeline (Baker, September 1996b).

Investigations at the site began in 1986 following a release of JP-5 fuel from the underground pipeline. Since 1986, approximately 10 separate investigations have been conducted to evaluate the extent of releases from underground fuel pipelines, the industrial wastewater line, and various underground storage tanks (USTs) at the site. These investigations determined that significant amounts of free product as well as chlorinated solvents are present. An RI and Baseline Risk Assessment (Baker, 1996b) and an FS (Baker, 1996c) summarizing the previous investigation data was completed in 1995.

The data generated during the RI (Baker, September 1996b) indicate that VOCs are the primary contaminants detected in the area. Specifically, chlorinated solvents were detected in the vicinity of LP-20 and LP-26. In addition, petroleum products occur east of Building LP-22 and south of Building LP-179 and are being handled as part of the Underground Storage Tank Program. Concentrations of VC, 1,1-DCE, 1,2-DCE, 1,2-dichloroethane (DCA), TCE, and benzene were observed in the shallow aquifer (Columbia) and concentrations of VC, 1,2-DCE, and TCE were also detected in the deep aquifer (Yorktown). The groundwater cleanup goals were established based on risk exposure of construction and utility workers who may be exposed to shallow groundwater.

A detailed ecological evaluation was not performed during the RI because the site is industrialized in nature and very limited habitat is present within the site. The entire area is flat and paved with asphalt or concrete. The only vegetation present is landscaped zones along roadways or parking areas (Baker, September 1996b). The site remains industrial with very little to no habitat.

8.3 Site 20 Remedial Actions

8.3.1 Remedy Selection

In 1996, a DD for the Building LP-20 Site was completed which required the shallow groundwater aquifer at the site be treated to reduce the threat to human health and the environment. The DD report identified the risks to the human health and ecological receptors, established the RAO, and defined the selected remedy. The selected remedy for Site 20 includes treatment of the groundwater using AS/SVE, LTM, and LUCs to meet the following RAOs:

- Prevent current and future exposure to human and ecological receptors to the contaminated shallow and Yorktown aquifer groundwater.
- Prevent further migration of contaminated shallow groundwater.

- Reduce contaminant concentrations in the shallow and Yorktown aquifer to risk-based levels defined in the DD.

The DD was limited to groundwater remediation as there was not a major discrete soil source area that would lend itself to remediation. Additionally, the entire site is covered by buildings or pavement and any contaminated soils in the vadose zone are, in effect capped, by low-permeability materials that minimize rainwater infiltration and subsequent leaching of contaminants.

The DD selected the following LUCs for Site 20:

- Prohibit use of the shallow and Yorktown aquifer groundwater.
- Ensure concrete and asphalt pavement are maintained to minimize exposure to site soils.

The LUC restrictions have been implemented as detailed in the RD for LUCs at Site 20 (CH2M HILL, April 2007c). The LUCs shall be maintained on all land and groundwater within the boundaries of Site 20 (**Figure 8-1**). The LUCs shall be maintained until the concentrations of hazardous substances in the groundwater has been reduced to levels that allow for unlimited used and unrestricted exposure.

8.3.2 Remedy Implementation

Construction of the AS/SVE system for the shallow aquifer began in 1997. The system is comprised of 53 AS wells and 27 SVE wells which are placed throughout the center and the downgradient extent of the contaminant plume in an effort to reduce the VOC concentrations that exceed cleanup goals (**Table 8-1**) in the contaminant source area and to prevent further migration of the plume offsite (**Figure 8-1**).The system began operating on April 14, 1998 and was switched to a two-week pulse pumping cycle in September 1999 to enhance performance. Optimization efforts have resulted in varying the system operation. Currently the system operates under various pulse strategies.

Sampling was completed in February 1998 at 15 monitoring wells to provide baseline analytical data before the AS/SVE system was started. Annual LTM was initiated at the same monitoring wells in February 1999. In 2002, MW-38 was demolished during construction activities adjacent to the site. Because VOCs were not detected in well MW-38 for the 2000, 2001, and 2002 sampling events, the well was not replaced. In 2006, MW-4 was also demolished due to construction activities adjacent to the site and was abandoned in place by removing the mount, cutting the well casing below the existing grade, filling the well with neat cement grout, and restoring the surface. Since VOC concentrations continued to be detected in samples collected from MW-4 before it was demolished, well MW-4R was installed in January 2008 to replace the demolished well.

8.3.3 System Operation and Maintenance

The standard O&M of the AS/SVE system are documented in the *Environmental Facility User Manual for Groundwater Remediation* (OHM, March 1998a). Maintenance associated with the operation of the AS/SVE system is minimal and consists of weekly site visits and system monitoring. There have not been any unexpected difficulties with the operation of the system at Site 20.

The RPO Team continually evaluates the operations and maintenance of the AS/SVE system, including operating costs, and makes adjustments as appropriate to increase system efficiency. To optimize the system, the AS system has been operated under various pulse strategies (e.g., 2 weeks on/2 weeks off; 1 week on/one week off). This strategy allows for electrical cost savings without hindering the effectiveness of the system.

8.4 Site 20 Progress since Last Review

The previous Five-Year Review found the current AS/SVE system at Site 20 to be protective of human health and the environment as the system has been effective in reducing the VOC concentrations within the contaminant plume. The previous Five-Year Review noted VOC concentrations were increasing in MW97-1D and it was recommended that VOC concentrations be monitored and, if deemed necessary, localized remedial options be evaluated.

An item identified during the review of the previous Five-Year Review was that the cleanup goals were risk-based values based on non-potable use of the groundwater. The NSN Partnering Team is developing the groundwater conceptual site model (CSM), evaluating the potential presence of a dense non-aqueous phase liquid (DNAPL), and evaluating the site impacts associated with historic filling activities. As a result of these Partnering Team activities, the path forward for the groundwater at Site 20 will be determined and included in the next Five-Year Review. The team has also agreed (October 21, 2008 partnering meeting) that documentation will be completed (likely a Non-Significant Differences document) to modify the groundwater clean up goals from the previous risk-based clean up goals to the federal MCLs.

As recommended in the previous Five-Year Review and as part of the function of the RPO Team, the RPO Team has continued to evaluate the LTM results and will continue to evaluate additional options for remedial action.

8.5 Site 20 Five-Year Review Process

8.5.1 Long-term Monitoring Data Review

The LTM program was implemented as a requirement in the Site 20 DD (Baker, 1996d) to evaluate the effectiveness of the remedial action. Baseline samples were collected in February 1998 at 15 monitoring wells and annual LTM was initiated at the same monitoring wells in February 1999. Monitoring was discontinued at MW-38 in 2002 and at MW-4 in 2006 because the monitoring wells were demolished during construction activities adjacent to the site. Well MW-4R was constructed in January 2008 to replace demolished MW-4, and LTM sampling at this well began in February 2008. Data collected during the baseline and last round of sampling for each well are provided in **Figure 8-2**. The findings for data collected through 2007 are presented in the 2007 LTM Report (CH2M HILL, December 2007f).

Of the monitoring wells included in the LTM, VOC concentrations are below the cleanup criteria in four of the wells: MW-14, MW-38, MW-97-2S, and MW99-1S. There is an overall decrease in the VOC concentrations detected at Site 20; however, concentrations remain

elevated in samples collected from both the shallow and deep monitoring wells and there has been a substantial increase in the concentration of 1,2-DCE detected in monitoring wells MW-2, MW-3, MW-5, and MW97-1D. Under anaerobic conditions, 1,2-DCE is a breakdown product of more highly chlorinated ethenes (PCE and TCE). Although the AS/SVE system is expected to create an aerobic environment at Site 20, areas not targeted by the system may be anaerobic. Therefore the increase of 1,2-DCE concentrations observed in some of the monitoring wells may be attributed to reductive dechlorination of parent compounds in anaerobic areas of the site. In addition to the increase in 1,2-DCE, overall VOC concentrations in MW-5 have increased from baseline and some VOC concentrations have substantially increased in deep well MW97-1D.

8.5.2 Site Inspections

Site inspections have been conducted at Site 20 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. No discrepancies have been observed at Site 20 during the quarterly inspections. The most recent inspection was conducted in February 2008. Photographs taken during the February 2008 site inspections are included in **Appendix A**.

8.5.3 Site Interviews

An interview with the O&M contractor was conducted on May 1, 2008. There were no significant problems regarding the site identified during the interview. Details of the Site 20 interview are provided in **Appendix B**.

8.6 Site 20 Technical Assessment

Is the remedy functioning as intended by the decision documents?

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates the remedy is functioning as intended by the DD. As the site is highly industrialized, it is effectively capped by asphalt and concrete, eliminating direct exposure pathways. Additionally, aquifer use restrictions (for both the shallow and deep aquifer) prevent the use of the groundwater.

The goal of the remedial action was to treat the contaminant plume in the shallow aquifer using an AS/SVE system to prevent migration of the plume offsite and into the deep aquifer, and reduce the contaminant concentrations to the established cleanup goals. The overall decrease in VOC concentrations suggests the AS/SVE system continues to decrease the total VOCs in the shallow aquifer. However, VOC concentrations remain elevated in some wells and are increasing in deep well MW97-1D located in the Yorktown aquifer. As the system has been in operating for 11 years and the VOC concentrations remain elevated. The groundwater treatment system may require additional enhancements to expedite the reduction of VOC concentrations.

Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-Year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review. There is no indication hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at LP-20, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment or the identified COCs.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for LP-20. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

A vapor intrusion indoor air evaluation was never performed for Building LP-20. The baseline risk assessment included in the RI indicated that indoor air sampling was not performed because the buildings are very large and well ventilated and solvents and chemicals were routinely used in Building LP-20; therefore, air sampling would not delineate between air concentrations originating from on-going activities at the site, and concentrations that may have volatilized into the building from the underlying groundwater plume. The vapor intrusion pathway was not evaluated for Site 20 during the remedial investigation/feasibility study. Since there are occupied buildings overlaying or within 100 feet of the VOC groundwater plume at Site 20, further evaluation of the vapor intrusion pathway in accordance with current vapor intrusion guidance (USEPA, November 2002) may be warranted to assess whether this pathway generates potentially unacceptable risk. As part of the AS/SVE pilot study, air monitoring was completed at 22 perimeter utility manholes and inside Building LP-26 to assess the degree of vertical and horizontal migration of the sparged contaminants outside the pilot test work area into manhole structures. Samples were collected before and immediately after system operation. There is limited air monitoring information available for Site 20, therefore an additional indoor air assessment will be required before the next Five Year Review.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

8.7 Site 20 Issues Identified

Table 8-2 presents the issues that have been identified for Site 20 based on this Five-Year Review.

Based on this Five-Year Review, the following issues identified in **Table 8-2** for Site 20 have been identified.

TABLE 8-2
Issues for Site 20
Naval Station Norfolk

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Vapor intrusion was not evaluated as a potential pathway as part of the RI/FS process for the site. Since there are buildings overlying the VOC groundwater plume, further evaluation of the vapor intrusion pathway at Site 20 may be warranted to assess whether this pathway generates potentially unacceptable risk. Since air monitoring was conducted as part of the AS/SVE system pilot study, additional air monitoring will be assessed before the next Five Year Review.	N	N
There is an overall decrease in the VOC concentrations detected at Site 20; however, concentrations remain elevated in samples collected at some of the monitoring wells. Therefore, the RPO team will need to evaluate supplements or enhancements to the current system in order to expedite the reduction of VOC concentrations.	N	Y

8.8 Site 20 Recommendations and Follow-up Actions

Table 8-3 presents recommendations and follow-up actions for Site 20.

TABLE 8-3
Recommendations and Follow-up Actions for Site 20
Naval Station Norfolk

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date	Affects Protectiveness (Y/N)	
				Current	Future
The vapor intrusion pathway was not evaluated for Site 20, as part of the remedial investigation/feasibility study for this Site. Since there are occupied buildings overlying or within 100 feet of the VOC plume in groundwater at Site 20, further evaluation of the vapor intrusion pathway to assess whether this pathway generates potentially unacceptable risk is warranted.	An assessment of the potential for vapor intrusion will be performed based on the presence of VOCs within the groundwater. This assessment will include an evaluation of the air monitoring results, obtained during the AS/SVE pilot study.	Navy EPA VDEQ	Sept. 2008	N	N
As the AS/SVE system has been in operating for 11 years and the VOC concentrations remain elevated, the groundwater treatment system may require additional enhancement to expedite the reduction of VOC concentration.	The NSN Partnering team will need to evaluate potential supplements or enhancements to the current system in order to ensure the remedial system achieves its objectives in a shorter timeframe.	Navy EPA VDEQ	Sept. 2008	N	Y

8.9 Site 20 Protectiveness Statement

The remedy at Site 20 consisting of the existing AS/SVE system is currently protective of human health and the environment and is expected to continue to be protective in the future. However, as limited air monitoring results are available for Site 20, an additional air assessment will be conducted before the next Five Year review. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater treatment system, LUCs, and the implementation of ICs.

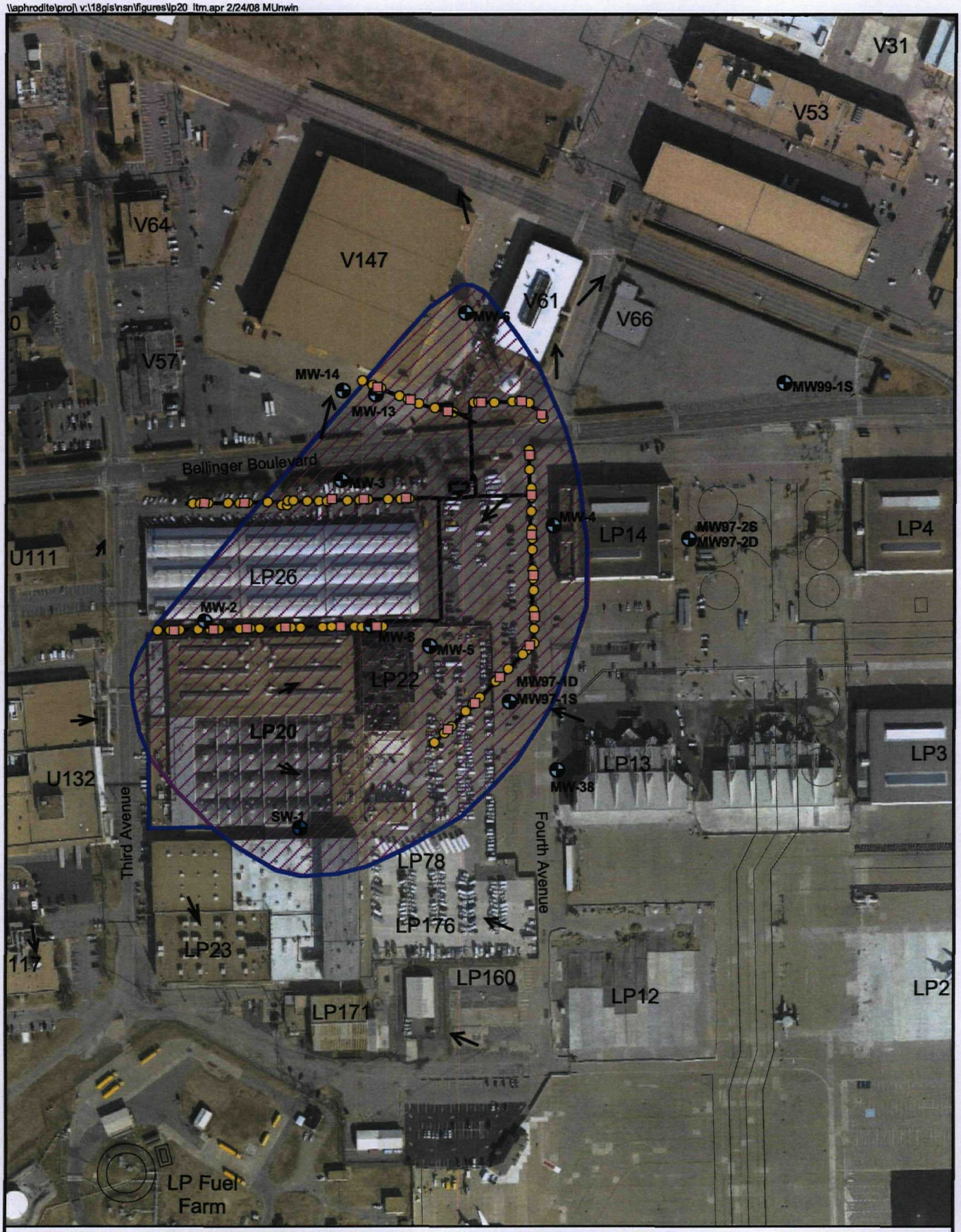
Table 8-1
Cleanup Goals for Groundwater at Site 20
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

Contaminant of Concern	Cleanup Goals (µg/L)
Trichloroethene	136
1,1-Dichloroethene	11
1,2-Dichloroethane[a]	172
1,2-Dichloroethene	306
Vinyl Chloride	6
Benzene	19

Notes:

[a] 1,2-Dichloroethane was not identified in the Decision Document, but was listed in the Long-term Monitoring Plan.

\\ephrodite\proj\ v:\18gis\nsn\figures\lp20_ltm.apr 2/24/08 MUnwin



LEGEND

- Monitoring Well
- Air Sparge Well
- Soil Vapor Extraction Well
- Piping for AS/SVE Systems
- Land Use Control Area
- Estimated Plume
- ← Direction of Groundwater Flow (February 1995)

February 2005 Aerial Photography

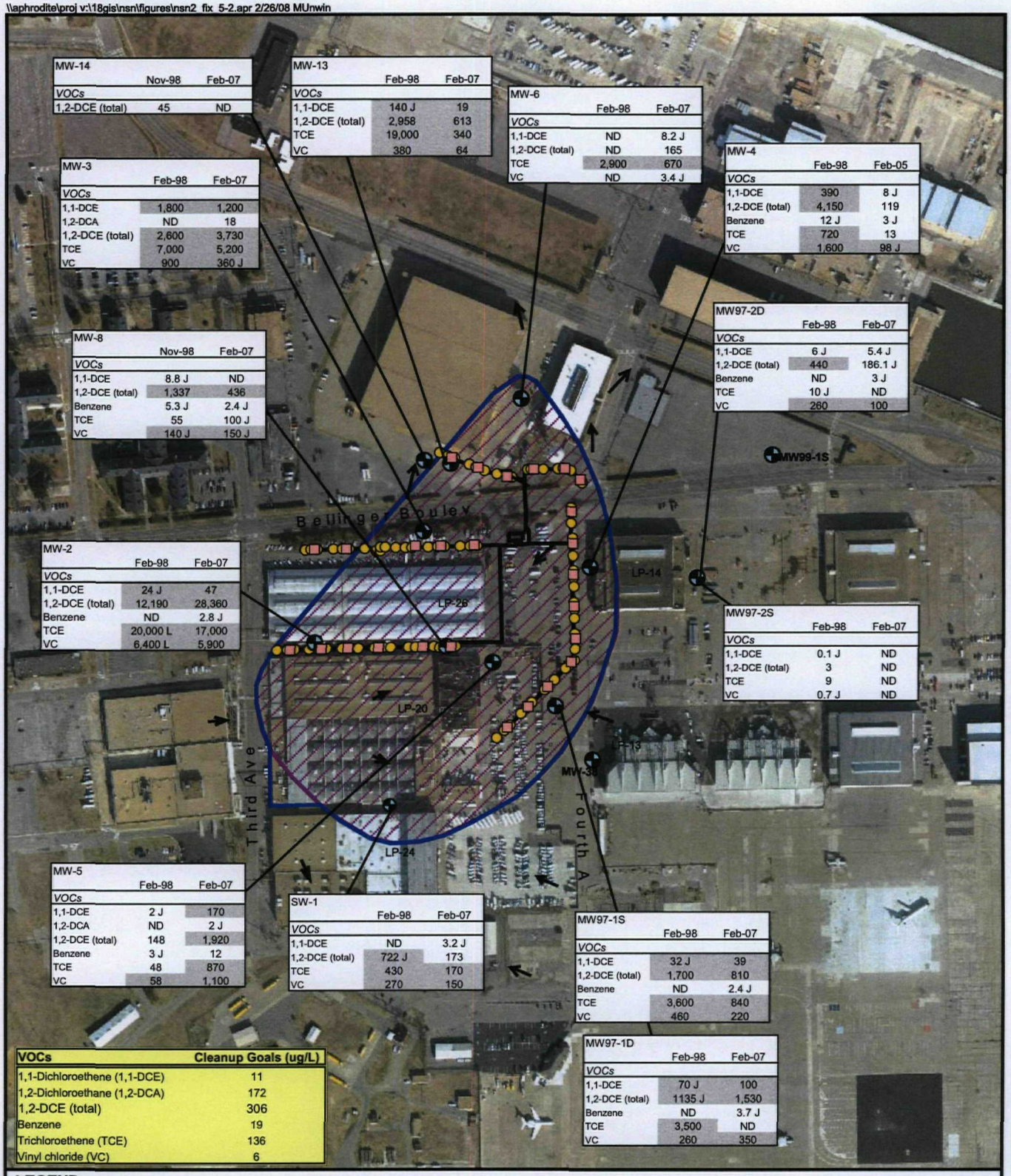
N

0 150 300 Feet

Figure 8-1
Site 20 AS/SVE Treatment System
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

\\aphrodite\proj v:\18gis\nsn\figures\nsn2_fix_5-2.apr 2/26/08 MUnwin



LEGEND

- Monitoring Well
- Air Sparge Well
- Soil Vapor Extraction Well
- Piping for AS/SVE Systems
- Land Use Control Area
- Estimated Plume

← Direction of Groundwater Flow (February 1995)
February 2005 Aerial Photography

Notes:
Units are in micrograms per liter (µg/L)
The detected concentration values that exceed cleanup levels are highlighted.
This figure only shows the first and last rounds of sampling at each sampling location.
ND - Not detected
J - Reported value is estimated
L = reported value may be biased low

Figure 8-2
Site 20, VOCs in Groundwater
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

N

0 200 400 Feet

CH2MHILL

SECTION 9

Site 22—Camp Allen Salvage Yard

9.1 Site 22 Chronology

Below is the chronology of the major site events for Site 22, Camp Allen Salvage Yard.

1940s - 1995	Use of site to salvage and process scrap materials generated at NSN
1982	Site 22 identified as a potential area of concern in the IAS
1993	A PA/SI Report completed
July 1996	RI Phase I conducted
August 1996	RI Phase II conducted
April 1997	NSN was placed on NPL
August 1998	NTCRA initiated at Site 22 for PCB- Contaminated Soil
May 2002	FS completed at Site 22
November 2002	NTCRA for Metals—Contaminated Soil
July 2003	NTCRA for Contaminated Sediment in the Pond Area
October 2003	Implementation of Five-Year Review process
February 2004	Proposed Plan for Site 22 made available to the public
September 2004	ROD for Site 22 completed

9.2 Site 22 Background

Site 22, the Camp Allen Salvage Yard, is located in the Camp Allen area south of Naval Station airfield and Interstate 564 (**Figure 9-1**). The site consists of approximately 22 acres of level ground, which is located between Areas A and B of Site 1, the Camp Allen Landfill. The facilities that surround Site 22 include the Naval brig, heliport, Camp Allen Landfill, the U.S. Marine Corps Camp Elmore, military housing, the Camp Allen Elementary School, and a civilian community (Glenwood Park).

A stormwater drainage basin (pond) is located on the eastern side of the site, north of Area B at Site 1. This pond collects stormwater that drains into a storm sewer that crosses the site. The storm sewer discharges into a ditch on the north side of the site and ultimately into Bousch Creek. In May 1999, the pond area was verified to be upland property and is therefore not a jurisdictional wetland.

Site 22 operated from the 1940s until 1995 salvaging and processing scrap materials generated at NSN. Salvage yard activities have included storage and management of waste oils, used chemicals, and scrap industrial and commercial equipment, in addition to metal smelting, various recycling activities, and miscellaneous burning. Acids, paint thinners,

solvents, pesticides, and transformers were also stored at the salvage yard. A PCB spill occurred at Site 22 in 1989 when a transformer was damaged by a forklift. PWC responded to the spill and conducted a preliminary cleanup at that time. When operations ceased in 1995, the buildings, incinerators, and rail lines were demolished.

A PA/SI was completed for CASY (Baker, May 1994a) and the investigation results indicated that the surface and subsurface soil were contaminated with PCBs, pesticides, and metals. Additional data were generated during the RI/RA (Baker, November 1999) and showed that the shallow and deep groundwater aquifers in the vicinity of the site as well as the sediment were contaminated with PCBs and metals. However, the HHRA identified no unacceptable risk from exposure to groundwater for the exposure scenarios evaluated. At present, the Virginia Department of Transportation (VDOT) has implemented a plan to extend the I-564 intermodal connector to the Norfolk International Terminals. The highway expansion will require that local utilities, Navy-owned ballfields, and a rail line be relocated, which will impact the northernmost section of Site 22. As a result, Site 22 will be covered and ballfields have been proposed for construction at the site to replace those demolished during the highway expansion. The Navy has no plans to construct housing units on this site, as it is intended to be used as a recreational area.

Ecological risks were not assessed during the RI; however, recommendations were made to address potential ecological risk to receptors in Bousch Creek from the storm drain system and the pond area.

9.3 Site 22 Remedial Actions

9.3.1 Remedy Selection

RI and FS reports were completed at Site 22 in 1999 (Baker, November 1999) and 2002 (Baker May 2002), respectively. A ROD, addressing the soil and sediment at the site, was signed in September of 2004. The ROD identified the risks to both human and ecological receptors exposed to soil and sediment, established the RAOs, and defined the selected remedy. The selected remedy for Site 22 includes LUCs for soil and sediment to meet the following RAOs:

- Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors.
- Reduce the threat of the covered sediment from becoming a potential source of contamination to ecological receptors in the pond area.

The ROD selected the following LUC objectives for Site 22:

- Prohibit the development and use of the property for residential housing, elementary and secondary schools, child-care facilities, and other activities that would pose an unacceptable risk to human and environmental receptors.
- Ensure no construction and maintenance activities, including activities that involve digging into the existing soil cover, are undertaken until the Navy implements adequate base procedures to ensure the integrity of the soil cover.

- Ensure no work on the storm drainage system or around the pond occurs without the use of appropriate worker precautions.

These LUC restrictions have been implemented as detailed in the *Revised Final RD for LUCs for Soil and Sediment at Site 22* (CH2M HILL, November 2005c). The LUCs shall be maintained on all land within the boundaries of Site 22 and the pond area adjacent to Site 22 until concentrations of contaminant have reduced to levels to allow unlimited use and unrestricted exposure, as stipulated in the ROD (Baker, September 2004). Because the shallow and deep aquifers at Sites 1 and 22 are considered one hydrogeologic unit, the cleanup of groundwater at Site 22 is included in the Site 1 groundwater extraction and treatment system (See Section 9.3.2).

9.3.2 Remedy Implementation

The initial remedial action at Site 22 consisted of the NTCRA and offsite disposal of metals and PCB contaminated soils in August 1998. Additional delineation of site contaminants in 2001 identified six metals hot spots throughout the site. As an interim measure, the Navy began removal of the hot spot soils in conjunction with the on-going PCB removal action. The hot spot and PCB contaminated soil removal continued through 2001 with the ultimate excavation of more than 16,000 yd^3 of material. The removal action achieved the soil PCB cleanup goals; however, the additional soil analytical data indicated that the extent of metals contamination was more widespread than previously estimated. It was estimated that approximately 29,000 yd^3 of soil remained at the site above the metals cleanup goals. Based upon the more comprehensive confirmation sampling and anticipated future land use of the site, the remedial measures for the site were re-evaluated. In March 2002, the NSN Tier I Partnering Team agreed that the placement of a soil cover was more cost effective than removal of the metals contaminated soils.

In 2003, the Navy completed an EE/CA addressing the contaminated sediment in the pond area. The removal action included the removal of approximately 1,825 yd^3 of contaminated sediment, the installation of a soil cover, and a cellular concrete block system over a geotextile covering for the remaining contaminated pond sediment. The engineered soil cover and the cover for the sediments in the pond were completed in June 2004.

In November 1998, a groundwater remediation system was placed in continuous operation. This system collects and treats VOCs in the groundwater underlying Areas A and B of Site 1 in addition to Site 22. The groundwater system also removes suspended solids in the groundwater to minimize fouling of the treatment system. Details of the groundwater treatment system are provided in Section 4.3.

9.3.3 System Operation and Maintenance

In accordance with the ROD, quarterly inspections of the soil and sediment covers are conducted to verify their integrity. Posted signs on the perimeter of the site are maintained to indicate the environmental monitoring at the site and access restrictions.

9.4 Site 22 Progress since the Last Review

This is the first Five-Year Review for the site.

9.5 Site 22 Five-Year Review Process

9.5.1 Long-term Monitoring Data Review

Because the shallow and deep aquifer at Sites 1 and 22 are considered one hydrogeologic unit, the groundwater at Site 22 has been characterized and will be addressed concurrent to the groundwater at Site 1. See Section 4.5.1 for groundwater monitoring results.

9.5.2 Site Inspections

Site inspections have been conducted at Site 22 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. No discrepancies have been observed at Site 22 during the quarterly inspections. The most recent inspection was conducted in February 2008. Photographs taken during the February 2008 site inspections are included in **Appendix A**.

9.5.3 Site Interviews

There is no active system at Site 22 and consequently no operator responsible for system maintenance. Therefore no interviews were needed for this site.

9.6 Site 22 Technical Assessment

Is the remedy functioning as intended by the DDs?

The covering of soils and sediments at Site 22 has achieved the remedial objectives to reduce the threat of contamination to ecological receptors.

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-Year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 22, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 22.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information that calls into question the protectiveness of the remedy.

9.7 Site 22 Issues Identified

There were no issues identified at Site 22 during this Five-Year Review.

9.8 Site 22 Recommendations and Follow-up Actions

There are no recommendations or follow-up actions identified for the remedy at Site 22.

9.9 Site 22 Protectiveness Statement

The cover systems at Site 22 prevent direct contact with soil and sediment. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers, LUCs, and implementation of ICs.

\\aphrodite\proj v:\18gis\nsn\figures\five_year_review_sites.apr 2/24/08 MUnwin

LEGEND

- Soil Cover
- Sediment Cover
- Land Use Control Area

February 2005 Aerial Photography

N

0 150 300 Feet

Figure 9-1
Site 22 - Camp Allen Salvage Yard
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 10

Site 23—Building LP-20 Plating Shop

10.1 Site 23 Chronology

Below is the chronology of the major site events for Site 23, Building LP-20 Plating Shop.

1986 - 1994	11 separate pre-remedial investigations in the LP area.
December 1990	Enforcement order
September, 1996	RI completed
February 1996	RCRA Phase I Investigation
October 1996	RCRA Phase II Investigation
December 1997	RCRA Phase III Investigation
December 1997	Risk-Based Closure Plan
September 2000	Revised Clean Closure Plan was submitted to VDEQ
July 2003	Site was transferred from the RCRA to the CERCLA program
July 2005	SI completed
December 2006	Final EE/CA completed
December 2007	Draft FS completed
February 2008	Final Completion Report completed
October 2008	Implementation of Five-Year Review process

10.2 Site 23 Background

Site 23, Building LP-20 Plating Shop, is located inside Building LP-20 (Site 20), which is one of many large buildings located northwest of the NAS main runway (**Figures 2-1 and 10-1**). Accordingly, the geology and hydrogeology at Site 23 is the same as Site 20 and the groundwater is not used as a potable water supply.

The Plating Shop occupies approximately 9,500 square feet (ft^2) of Building LP-20, which a little less than a quarter of the total area of the building. In the past, a portion of the building was used for aircraft engine overhaul and maintenance. Currently, the building is used as a motor pool and office space; however, the former Plating Shop area within the building, designated Site 23 is currently not in use. It is anticipated that use of the site will continue to be industrial. No residential development is planned or expected for Building LP-20 or the immediate surrounding area.

Previous activities in the plating shop included disassembling, stripping, and replating metal parts. The shop contains seven process pits extending beneath the concrete slab floor which were used for cleaning, stripping, and plating engine parts. The process tanks and equipment were also located in pits. The floor and pits were lined with corrosion resistant brick tiles. The shop also contains a drainage system for the collection of wastewater from the pits and delivery to the industrial Wastewater Treatment Plant (WWTP).

During a 1989 site visit, VDEQ observed violations of the VHWMRs. An enforcement order was effective in December 1990. Under RCRA, the Clean Closure Plan and Contingency Plan were completed in 1993 and approved by VDEQ in September 1994. The Navy requested a modification of the plans to conduct a risk-based closure. Multiple phases of investigation were conducted for partial implementation of the Risk-based Closure Plan (Versar, December 1997). The RA indicated unacceptable industrial risk at 17 soil locations, but no unacceptable risks with exposure to the Plating Shop concrete floors. Groundwater was recommended to be addressed under a post closure monitoring program. Final closure was not achieved; however, under the RCRA program, a partial closure of the site was performed that included the removal of the process tanks and equipment located in the pits and removal of the piping for decontamination or disposal (Versar, December 1997). In September 2000, a revised Clean Closure Plan was submitted to VDEQ. However, in July 2003, the Navy decided to move the site from the RCRA to the CERCLA program.

A PA/SI is the first step in evaluating a site under CERCLA; however, in November 2003 the NSN Tier I Partnering Team agreed that the existing documents completed under the RCRA program can be used in lieu of a formal PA/SI. In addition, the NSN Tier I Partnering Team joint-scoped additional soil investigation activities. The additional investigation was conducted in December of 2004. The results of the investigation showed that there were concentrations of one VOC, semivolatile organic compounds (SVOCs), and metals above the residential and industrial risk-based concentrations (RBCs).

In May 2005, the NSN Tier I Partnering Team agreed to conduct an interim removal action to address the site soils. Accordingly, an EE/CA was completed in December 2006 (CH2M HILL, December 2006b) and construction activities were initiated in June 2006. All debris and brick tiling located within the process pits and brick tiles covering the floor were removed and appropriately disposed. The Plating Shop pits and interconnected conduits were filled with flowable concrete fill, and a 6-inch concrete cover with an industrial floor sealant was constructed to prevent potential exposure to underlying impacted soil. The construction activities are documented in the *Final Completion Report, Site 23, LP-20 Plating Shop, Naval Station Norfolk, Norfolk, Virginia* Construction (Shaw, February 2008).

10.3 Site 23 Remedial Actions

10.3.1 Remedy Selection

The completion of the interim removal action to place the concrete cover at Site 23 provided the protective barrier to prevent exposure to contaminated soils beneath the former plating shop. A FFS was developed to evaluate the implementation of land use controls to prevent future exposure.

The FFS was submitted in March of 2008 (CH2M HILL, March 2008), the Proposed Plan was issued in September of 2008 (CH2M HILL, September 2008), and the ROD was signed in September 2008 (CH2M HILL, September 2008). The ROD identified the risks to human health and the environment, established the RAO, and defined LUCs as the selected remedy. The purpose of the LUCs was to minimize exposure to contamination present in the soil. Based on future use of Site 23 as an industrial site, the existing concrete cover prevents an exposure to soil. Construction workers, however, could be exposed to impacted soil during excavations or other intrusive activities. The selected remedy for Site 23 is LUCs to meet the following RAO:

- Prevent unlimited use and unrestricted exposure to soil beneath the former process pits that poses a potential unacceptable risk to human health.
- Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors.

The ROD selected the following LUC objectives for Site 23:

- Prohibit any action that would disturb the integrity of the concrete cover.
- Ensure concrete and asphalt pavement are maintained to minimize exposure to site soils.
- Prohibit residential use.

These LUC restrictions will be implemented with the actions that will be detailed in the forthcoming RD for LUCs at Site 23. The LUC shall be maintained within the boundaries of Site 23 until concentrations of contaminant have reduced to levels to allow unlimited use and unrestricted exposure, as stipulated in the ROD.

As documented in the ROD, since Site 23 is within the boundaries of Site 20; therefore, the groundwater at Site 23 is being addressed with the remedial action implemented for Site 20 (see Section 8).

10.3.2 Remedy Implementation

Remedial action was implemented at Site 23 on June 4, 2008. Upon completion of the ROD, engineering controls that will be implemented include quarterly inspections and signage.

10.3.3 System Operation and Maintenance

In accordance with the ROD, quarterly inspections of the cover are conducted to verify its integrity. Posted signs on the perimeter of the site are maintained to maintain access restrictions.

10.4 Site 23 Progress Since Last Review

This is the first Five-Year Review for Site 23, Building LP-20 Plating Shop.

10.5 Site 23 Five-Year Review Process

10.5.1 Long-term Monitoring Data Review

The groundwater at Site 23 is being monitored as part of the LTM program at NSN for Site 20. Details of the groundwater evaluation for Site 20 are provided in Section 8.5.1.

10.5.2 Site Inspections

Upon completion of the ROD, site inspections will be completed at Site 23 quarterly to ensure LUCs are maintained. The inspection findings and resolutions will be summarized in an annual report that is provided to the USEPA and VDEQ for review.

10.5.3 Site Interviews

There is no active system at Site 23 and consequently no operator responsible for system maintenance. Therefore no interviews were needed for this site.

10.6 Site 23 Technical Assessment

Is the remedy functioning as intended by the DDs?

Based on the review of the documents, ARARs, risk assumptions, and inspections, the remedy is functioning as intended by the ROD. Implementation and maintenance of ICs has prevented exposure to contaminated media.

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-Year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-Year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 23, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment.

Changes in Risk Assessment Methodologies. There have been no changes in methodologies (screening level or risk ratio evaluation methodologies) since the EE/CA screening HHRA was performed.

There have been no changes that would affect the effectiveness of remedy (LUCs) there is no exposure or risk, and remedy is effective.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

10.7 Site 23 Issues Identified

There were no issues identified at Site 23 during this Five-Year Review.

10.8 Site 23 Recommendations and Follow-up Actions

There are no recommendations or follow-up actions identified for the remedy at Site 23.

10.9 Site 23 Protectiveness Statement

The cover at Site 23 prevents direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cover, LUCs, and implementation of ICs.

\\aphrodite\proj v:\18gis\nsn\figures\five_year_review_sites.apr 2/24/08 MUnwin

LEGEND

Land Use Control Area

February 2005 Aerial Photography

N

0 75 150 Feet

Figure 10-1
Site 23 - Building LP-20 Plating Shop
Five-Year Review 2008
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 11

Five-Year Review Summary

The completion of the next Five-Year Review for NSN is required by October 2013, 5 years from the completion of this review.

SECTION 12

References

A. T. Kearney. 1992. *Revised Final Phase II RCRA Facilities Assessment of the Norfolk Naval Base-Sewells Point.* March.

Agviq/CH2M HILL. 2008a. *LTM Site 6, CD Landfill Tech Memo Naval Station Norfolk, Norfolk, Virginia.* February.

Agviq/CH2M HILL. 2008b. *Construction Closeout Report, Upper Reaches of Bousch Creek, Site 1, Camp Allen Landfill, Naval Station Norfolk, Norfolk, Virginia.* September.

Agviq/CH2M HILL. 2006. *Landfill Cap Integrity Inspection Tech Memo at Site 6, CD Landfill, Naval Station Norfolk, Norfolk, Virginia.* October.

Baker. 2004. *Final Record of Decision Site 22; Camp Allen Salvage Yard Site 22 Naval Station Norfolk, Norfolk, Virginia.* September.

Baker. 2002. *Final Feasibility Study, Site 22 Camp Allen Salvage Yard Naval Station Norfolk, Norfolk, Virginia.* May.

Baker. 1999. *Final Remedial Investigation/Risk Assessment Report for Camp Allen Salvage Yard Naval Station Norfolk, Norfolk, Virginia.* November.

Baker. 1998a. *Final Proposed Remedial Action Plan Operable Unit NO. 2 CD Landfill Naval Base, Norfolk, Virginia.* June.

Baker. 1998b. *Final Record of Decision- OU2, CD Landfill Site, Naval Base, Norfolk, Virginia.* September 28, 1998.

Baker. 1997. *Draft Baseline Sampling Report, Camp Allen Landfill, Naval Base, Norfolk, Norfolk, Virginia.* May.

Baker. 1996a. *Phase I Relative Risk Ranking (RRR) System Data Collection Sampling and Analysis Report* January.

Baker, 1996b. *Final RI and Baseline Risk Assessment for Building LP-20 Site, Naval Base Norfolk, Norfolk, Virginia.* September.

Baker, 1996c. *Final Feasibility Study, for Building LP-20 Site, Naval Base Norfolk, Norfolk, Virginia.* September.

Baker. 1996d. *Final Decision Document CD Landfill Naval Base Norfolk, Norfolk, Virginia.* October.

Baker. 1996e. *RRR System Data Collection Sampling and Analysis Report Phase II.* December.

Baker. 1995a. *Baseline Risk Assessment, Camp Allen Landfill.* February.

Baker. 1995b. *Final Proposed Remedial Action Plan Camp Allen Landfill Naval Base Norfolk, Virginia.* March.

Baker Environmental, Inc. (Baker). 1995c. *Final Decision Document, Camp Allen Landfill, Naval Base Norfolk, Norfolk, Virginia.* July.

Baker. 1995d. *Final Remedial Investigation CD Landfill Naval Base, Norfolk, Virginia.* December.

Baker. 1994a. *Final Preliminary Assessment/Site Investigation Report Camp Allen Salvage Yard Naval Base, Norfolk, Virginia.* May.

Baker. 1994b. *Final Camp Allen Landfill Remedial Investigation/Feasibility Study Report, Naval Base Norfolk, Norfolk, Virginia.* July.

Baker. 1993. *Final Decision Document Removal Action at Camp Allen Landfill, Area B Naval Base Norfolk, Norfolk, Virginia.* November.

Baker 1992. *Final Project Plans. Remedial Investigation/ Feasibility Study for CD Landfill Site,* Naval Base Norfolk, Norfolk Virginia. July 1992.

Baker, December 1. *Draft Final Feasibility Study Building LP-20 Site, Naval Base Norfolk, Norfolk, Virginia.* December.

CH2M HILL. 2008a. *Final Focused Feasibility Study for Site 23 – Building LP-20 Plating Shop, Naval Station Norfolk, Norfolk, Virginia.* March.

CH2M HILL. 2008b. *Final Site Management Plan Fiscal Year 2008 Naval Station Norfolk, Norfolk, Virginia.* April.

CH2M HILL. 2008c. *Final Annual Site Inspection Report, May 2007 to February 2008. Naval Station Norfolk, Norfolk, Virginia.*

CH2M HILL. 2008d. *Proposed Plan Site 23, Buiilding LP-20 Plating Shop: Naval Station Norfolk.* September.

CH2M HILL. 2008e. *Final Record of Decision Site 23: Building LP-20 Plating Shop, Naval Station Norfolk, Virginia.* September.

CH2M HILL. 2007a. *Groundwater Management Plan for Site 6, CD Landfill Naval Station Norfolk, Norfolk, Virginia.* March.

CH2M HILL, 2007b. *Final Remedial Design for Land Use Controls at Site 1, Naval Station Norfolk, Norfolk, Virginia.* April.

CH2M HILL, 2007c. *Final Remedial Design for Land Use Controls for Site 20, Building LP-20 Site, Naval Station Norfolk, Norfolk, Virginia.* April.

CH2M HILL, 2007d. LUC RD for Site 3. *Final Remedial Design for Land Use Controls for Site 3, Q-Area Drum Storage Yard, Naval Station Norfolk, Norfolk, Virginia.* April.

CH2M HILL, 2007e. *Final Long-Term Monitoring Plan for Four Sites, Naval Station Norfolk, Norfolk, Virginia.* May.

CH2M HILL, 2007f. *Draft Long-Term Monitoring Report for Four Sites, Naval Station Norfolk, Norfolk, Virginia.* December.

CH2M HILL. 2006a. *Ecological Risk assessment – Step 7, Upper Reaches of Bousch Creek, Camp Allen Landfill (Site 1), Naval Station Norfolk, Norfolk, Virginia.* November.

CH2M HILL. 2006b. *Final Engineering Evaluation/Cost Analysis, Site 23-Building LP-20 Plating Shop Naval Station Norfolk, Norfolk Virginia.* December.

CH2M HILL. 2005a. *Final Remedial Design for Land Use Controls for Site 2, NM Slag Pile, Naval Station Norfolk, Norfolk, Virginia.* January 28.

CH2M HILL, 2005b. *Draft Site Investigation Report, Site 23, Building LP-20 Plating Shop, Naval Station Norfolk, Norfolk, Virginia.* July.

CH2M HILL. 2005c. *Revised Final Remedial Design for Land Use Controls for Soil and Sediment at Site 22, Naval Station Norfolk, Norfolk, Virginia.* November.

CH2M HILL 2004. *First Determination Report to Site 6, CD Landfill, Naval Station Norfolk, Virginia.* March

CH2M HILL. 2003. *Final Five-Year Review Report Naval Station Norfolk, Norfolk, Virginia.* October.

CH2M HILL. 2002. *Final Annual Post- Closure Monitoring Report for 2001 CD Landfill Naval Station Norfolk, Norfolk, Virginia.* February 2002.

CH2M HILL. 2000a. *Landfill Closure Certification Report, Landfill Cap, CD Landfill, Naval Base Norfolk, Norfolk, Virginia.* August.

CH2M HILL. 2000b. *Final Record of Decision NM Slag Pile Naval Station Norfolk, Norfolk, Virginia.* October.

CH2M HILL. 1999a. *Final Proposed Remedial Action Plan Naval Base, Norfolk, Norfolk, Virginia.* January.

CH2M HILL. 1999b. *Final Remedial Action Design Site 2, NM Slag Pile Naval Base, Norfolk, Norfolk, Virginia.* September.

CH2M HILL. 1998a. *Final Remedial Investigation Site 2, NM Slag Pile Naval Base, Norfolk, Norfolk, Virginia.* August.

CH2M HILL. 1998b. *Camp Allen Landfill Long-Term Monitoring Plan,* module to the *Long-Term Monitoring Plans for Four Sites at Naval Base Norfolk, Norfolk, Virginia.* September.

CH2M HILL. 1998c. *Final Feasibility Study Site 2, NM Slag Pile Naval Base, Norfolk, Norfolk, Virginia.* September.

CH2M HILL. 1997. *Final Master Work Plan Naval Base, Norfolk, Norfolk, Virginia.* October.

CH2M HILL, Baker, CDM. 1998. *Basis of Design for the Landfill Cap CD Landfill Naval Station Norfolk, Norfolk, Virginia.* October.

EDAW, Inc. 1995. *Naval Base Norfolk 2010 Land Use Plan.* August.

Environmental Science & Engineering, Inc. (ESE). 1996a. *Revised Draft Final Remedial Investigation Feasibility Study Q Area Drum Storage Yard Norfolk Naval Base, Norfolk, Virginia.* May.

ESE. 1996b. *Final Document Decision (DD) for Q-Area Drum Storage Yard, Norfolk Naval Base, Norfolk, Virginia.* November.

ESE. 1983. *Initial Assessment Study of Sewells Point Naval Complex, Norfolk, Virginia.* February.

Malcolm Pirnie. 1988. *Installation Restoration Program, Remedial Investigations, Interim Report, Naval Base, Norfolk, Virginia.* May.

Navy. 1995. Letter from N.M. Johnson/Navy to Stacey Driscoll/USEPA, Response to Comments on the Draft Final PRAP, Camp Allen Landfill, Norfolk Naval Base, Norfolk, Virginia. March.

NSN Tier I Partnering Team Consensus, January 2008. Partnering Team Meeting January 15, 2008.

NSN Tier I Partnering Team Consensus, January 2008. Partnering Team Meeting November 15, 2007.

NSN Tier I Partnering Team Consensus, January 2008. Partnering Team Meeting May 4, 2005.

OHM. 1998a. *Draft Environmental Facility User Manual for Groundwater Remediation Building LP-20 Naval Base Norfolk, Norfolk, Virginia.* March.

OHM. 1998b. *Draft Environmental Facility User Manual for Groundwater Remediation Q-Area Drum Storage Yard Naval Base Norfolk, Norfolk, Virginia.* August.

OHM. 1997. *Operations and Maintenance Manual for Soil and Groundwater Remedial Action Camp Allen Landfill – Areas A & B Naval Station, Norfolk, Virginia.* August.

Shaw Environmental, 2008. *Final Completion Report, Site 23-Building LP-20 Plating Shop, Naval Station Norfolk, Norfolk, Virginia.* February.

USEPA. 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance. November.

USEPA. 2001. *Comprehensive Five-Year Review Guidance.* June.

USEPA. 1994. *Aerial Photographic Site Analysis.* September.

Versar, Inc. (Versar). 1997. *Risk-Based Closure Plan Metal Plating Shop Building LP-20 Naval Base Norfolk, Norfolk, Virginia.* December.

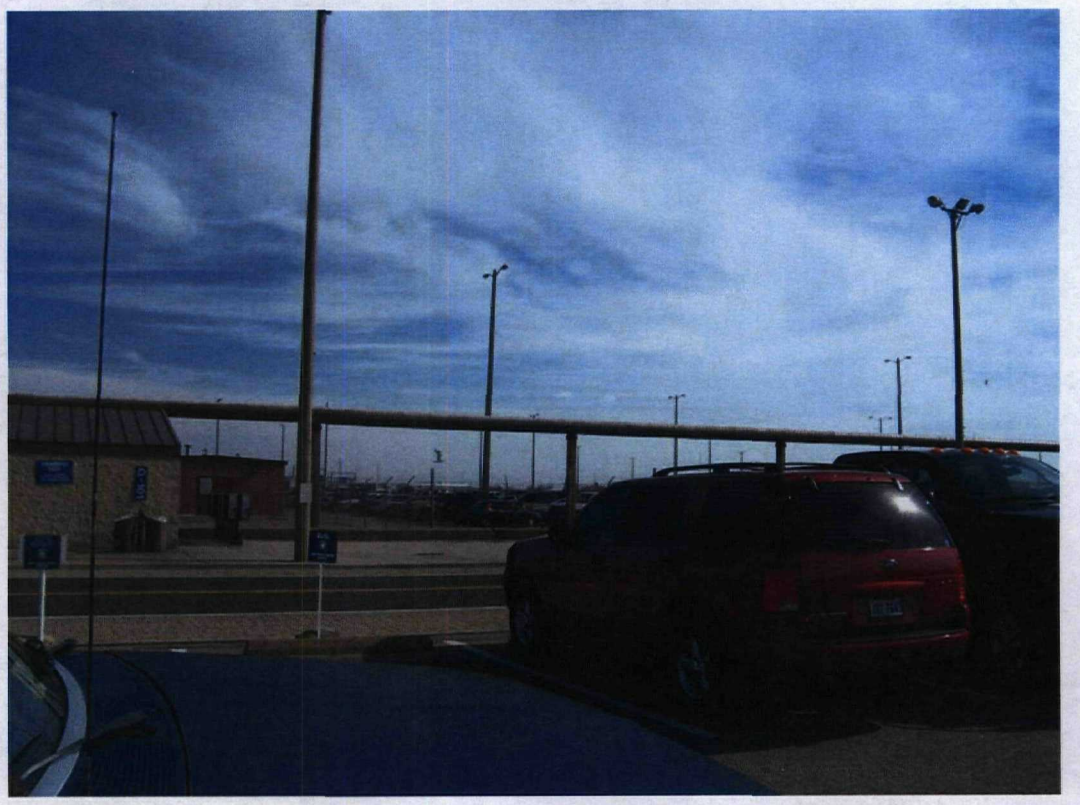
Appendix A
Site Inspection Photographs

Site 1 – Camp Allen Landfill (CALF)

Site 1 – Camp Allen Landfill (CALF)

Site 2—NM Slag Pile

Site 3—Q Area Drum Storage Yard (QADSY)



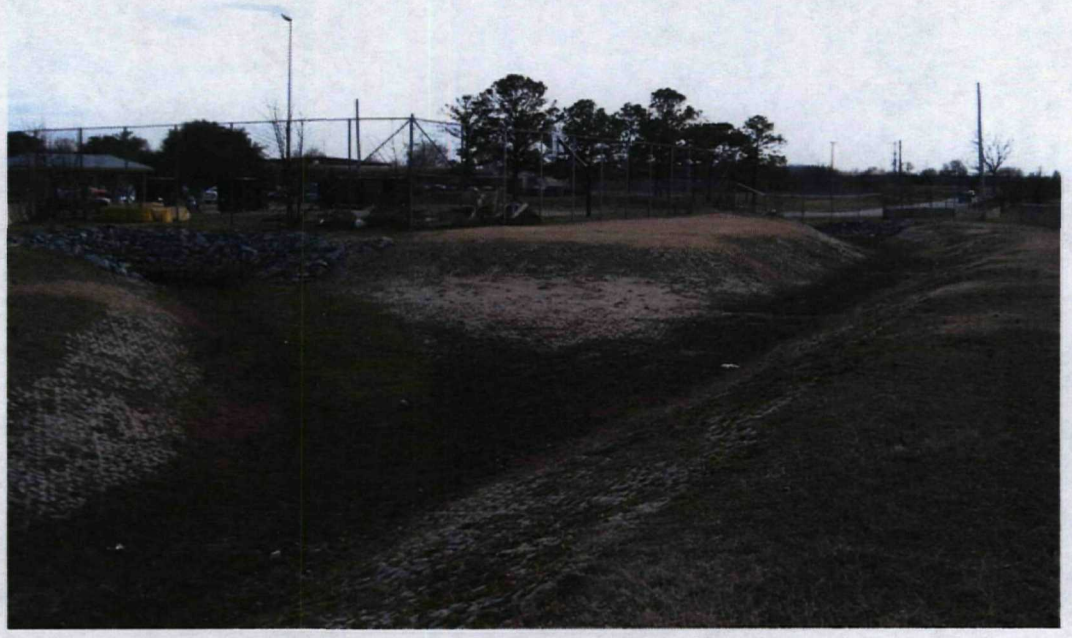
Site 6—CD Landfill

Site 6 – CD Landfill

Site 20 – Building LP-20

Site 22—Camp Allen Salvage Yard (CASY)

Site 22 – Camp Allen Salvage Yard (CASY)



Site 23 – Building LP-20 Plating Shop

Appendix B
Site Interviews

INTERVIEW RECORD

Site Name: NAVAL STATION NORFOLK	EPA ID No.: VA6170061463
Subject: O&M CONTRACTOR / IR SITE 1	Time: 11:15 Date: 2-1-08
Type: • Telephone • Visit • Other Location of Visit: OFFICE TO OFFICE	• Incoming • Outgoing

Contact Made By:

Name:	Title:	Organization:
PAUL LANDIN	PROJECT MGR	CH2M HILL

Individual Contacted:

Name:	Title:	Organization:
MARK PISARCIK	PROJECT MGR	SHAW E&I

Telephone No: 757.640.6936 Fax No: 757.640.6201 E-Mail Address: Mark.Pisarcik@shawgrp.com	Street Address: 500 EAST MAIN ST. SUITE 1630 City, State, Zip: NORFOLK, VA 23510

IR SITE 1 **Summary Of Conversation** CAMP ALLEN LANDFILL

- IS THE REMEDY FUNCTIONING AS EXPECTED?
  RESPONSE: YES, THE GROUNDWATER EXTRACTION SYSTEM IS CONTAINING GROUNDWATER AT THE SITE, 3-4 MILLION GALLONS PER MONTH ARE EXTRACTED/TREATED.
- IS THERE CONTINUOUS O&M PRESENCE? WHAT ARE ROLES?
  RESPONSE: TWO STAFF ARE ASSIGNED FULL TIME TO THE SITE. DUTIES INCLUDE SYSTEM OPERATION, MAINTENANCE, TROUBLE-SHOOTING, ETC. MONTHLY MAINTENANCE SCHEDULES / WEEKLY UPDATES ARE PROVIDED
- CHANGES IN O&M THAT AFFECT PROTECTIVENESS?
  RESPONSE: NONE THAT AFFECT PROTECTIVENESS OR EFFECTIVENESS. CURRENTLY UPGRADING EXTRACTION WELL VAULTS TO HAVE AUTO-SHUT OFF IF HIGH WATER IS DETECTED TO PROTECT ELECTRICAL COMPONENTS.
- ANY UNEXPECTED O&M DIFFICULTIES OR COST?
  RESPONSE: SCALING OF TREATMENT SYSTEM COMPONENTS DUE TO METALS IN SHALLOW GROUNDWATER REQUIRES REGULAR MAINTENANCE. REDUCED EXTRACTION RATE 2-4 WELLS
- COMMENTS/SUGGESTIONS?
  RESPONSE: CONTINUE OPTIMIZATION STUDIES; EVALUATE AREA ADJACENT

INTERVIEW RECORD

Site Name: NAVAL STATION NORFOLK		EPA ID No.: VA6170061463
Subject: O&M CONTRACTOR / IR SITE 3		Time: 11:30 Date: 2-1-08
Type: ~~Telephone~~ • Visit • Other Location of Visit: OFFICE TO OFFICE		• Incoming • Outgoing

Contact Made By:

Name: PAUL LANDIN	Title: PROJECT MGR	Organization: CH2M HILL

Individual Contacted:

Name: MARK PISARCIK	Title: PROJECT MGR	Organization: SHAW
Telephone No: 757.640.6936 Fax No: 757.640.6201 E-Mail Address: Mark.Pisarcik@shawgrp.com	Street Address: 500 EAST MAIN ST City, State, Zip: SUITE 1830 NORFOLK, VA 23510	

IR SITE 3 **Summary Of Conversation** Q-AREA

- IS THE REMEDY FUNCTIONING AS EXPECTED?
  RESPONSE: YES, AIR SPARGE / SOIL VAPOR EXTRACTION (AS/SVE) SYSTEMS INSTALLED & OPERATED AT TWO AREAS AOC 1 & AOC 2. OPTIMIZATION/CLOSEOUT STRATEGY IMPLEMENTED, AOC-1 SHUT DOWN SINCE JUNE 2005 (MONITORING OF GROUNDWATER CONTINUES). AOC-2 STILL IN CONSTANT OPERATION
- TRENDS THAT SHOW CONTAMINANT LEVELS ARE DECREASING?
  RESPONSE: YES, AOC-1 ONLY HAS ONE WELL ABOVE CLEAN-UP GOAL/MCL, AND HAS BEEN SHUT OFF SINCE JUNE 2005
- IS THERE CONTINUOUS O&M PRESENCE?
  RESPONSE: SITE VISITS/SYSTEM MONITORING IS CONDUCTED AT LEAST ONCE PER WEEK. INCLUDES REGULAR PREVENTIVE MAINTENANCE
- CHANGES IN O&M THAT AFFECT PROTECTIVENESS OR EFFECTIVENESS?
  RESPONSE: AS NOTED PREVIOUSLY, AOC-1 HAS BEEN SHUT DOWN SINCE JUNE 2005, ONE WELL ABOVE CLEAN UP GOAL CONTINUES TO BE MONITORED
- ANY UNEXPECTED MAINTENANCE OR O&M DIFFICULTIES?
  RESPONSE: A 2-INCH AS HEADER PIPE WAS DAMAGED BY ANOTHER CONTRACTOR PERFORMING INTRUSIVE WORK. SYSTEM WAS TEMPORARILY SHUT DOWN AND REPAIRS WERE COMPLETED AS SOON AS POSSIBLE

- OPTIMIZATION MEASURES?
  RESPONSE: (A) AOC 1 SHUT DOWN WITH CONTINUED GROUNDWATER MONITORING

(B) A NEW AIR SPARGE WELL WAS INSTALLED IN JUNE 2006 TO EXTEND THE SYSTEM NEAR A HOT SPOT AT CMW-202 (AOC-2)

INTERVIEW RECORD

Site Name: NAVAL STATION NORFOLK	EPA ID No.: VAG170061463	
Subject: O&M CONTRACTOR / IR SITE 20	Time: 11:45	Date: 2-1-08
Type: • ~~Telephone~~ • Visit • Other Location of Visit:	• Incoming • ~~Outgoing~~	

Contact Made By:

Name: PAUL LANDIN	Title: PROJECT MANAGER	Organization: CH2M HILL

Individual Contacted:

Name: MARK PISARCIK	Title: PROJECT MANAGER	Organization: SHAW
Telephone No: 757.640.6936 Fax No: 757.640.6201 E-Mail Address: Mark.Pisarcik@shawgrp.com	Street Address: 500 EAST MAIN ST. SUITE 1030 City, State, Zip: NORFOLK, VA 23510	

IR SITE 20 **Summary Of Conversation** BLDG LP-20

- IS THE REMEDY FUNCTIONING AS DESIGNED?
  RESPONSE: YES THE SYSTEM IS OPERATING AS INTENDED. REMOVAL RATES ARE DECREASING OVER THE LAST 5 YEARS.
- IS THERE CONTINUOUS O&M PRESENCE?
  RESPONSE: MINIMUM WEEKLY, SAME AS SITE 3
- CHANGES IN O&M THAT AFFECT PROTECTIVENESS OR EFFECTIVENESS?
  RESPONSE: NO SIGNIFICANT CHANGES
- UNEXPECTED O&M MAINTENANCE / DIFFICULTIES?
  RESPONSE: NO UNEXPECTED DIFFICULTIES
- OPTIMIZATION EFFORTS?
  RESPONSE: THE SPARGE SYSTEM HAS BEEN OPERATED UNDER VARIOUS PULSE STRATEGIES (2 WK ON / 2 WK OFF, 1 WK ON / 1 WK OFF, ETC). PULSE STRATEGY SAVE ON ELECTRICAL COST. NO SIGNIFICANT CHANGE IN RESULTS
- RECOMMENDATIONS?

RESPONSE: CONTINUE OPTIMIZATION STUDIES