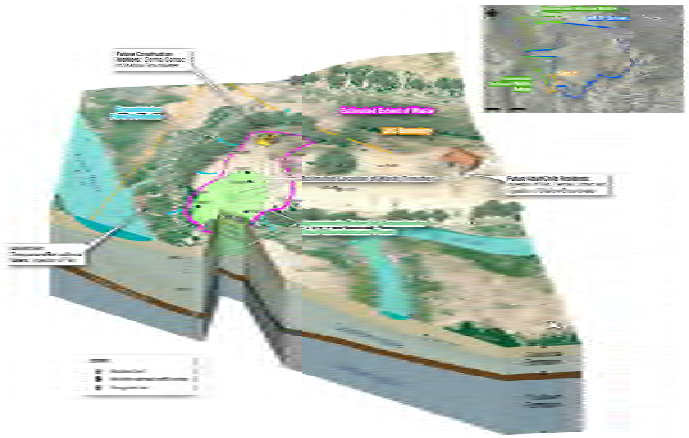
NAVFAC
Naval Facilities Engineering Command

Final

Navy Environmental Restoration Program Management and Monitoring Approach



May 2012

Preamble

As part of the Navy's effort to incorporate continual process improvements, this document was developed to present an improved approach for documentation and optimization of post-Record of Decision site management and monitoring (formerly referred to as long-term monitoring). This document is designed to assist Remedial Project Managers in preparing management and monitoring reports for the Navy Environmental Restoration Program. This document is set up to provide insight into each of the key elements of site management and monitoring to more effectively reach site closure:

- Summarizing data quality objectives
- Understanding cleanup goals and expected outcomes of remedy components
- Continuously optimizing management and monitoring approaches

This document is organized to follow a suggested report outline. The header of each page represents a key section of a site management and monitoring report. The columns on each page contain the following information and tips:

- **Left column** - Provides insight into the content and purpose of the report section and suggested tips to better evaluate and present information.
- **Center column** - Depicts an example and/or relevant section of a Management and Monitoring Report.
- **Right column** - Provides examples or additional information regarding presentation of report content, including where electronic links can be useful.

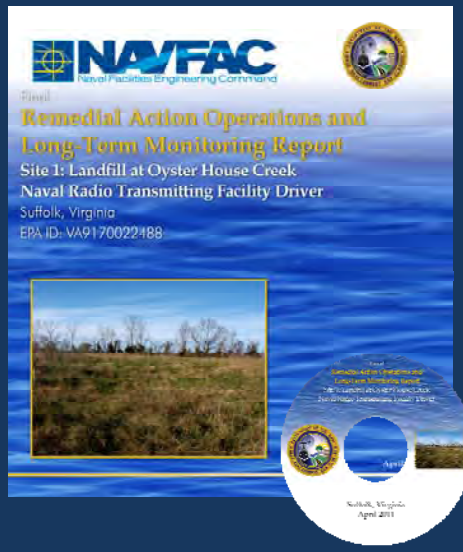
Suggested Site Management and Monitoring Report Outline

- Executive Summary
- Introduction
- Site Location, History, and Characteristics
  - Conceptual Site Model
  - Previous Investigations and Decisions
- Remedial Action Objectives and Cleanup Levels
- Remedy Implementation and Evaluation
  - Land Use Controls
  - Active Treatment
  - Monitoring Program
    - Data Quality Objectives
    - Sampling and Analysis
    - Data Evaluation
  - Remedy Performance and Protectiveness
  - Cost
- Optimization
- Site Closeout Strategy
- Conclusions and Recommendations
- Acronyms and Abbreviations
- References

Objective: Develop a Standardized Approach for Site Management and Monitoring

This outline is not designed to be a one-size-fits-all template. Depending on variations within your selected remedy, the outline can be revised to produce the level of detail needed to balance the use of streamlining and visualization tools for better site-specific data presentation.

This document is designed to be viewed electronically. This format allows the reader to zoom into the detail presented in the color graphics.



Document Production

For the Administrative Record or Site File, include a complete bookmarked PDF of the document on CD.

Interactive Documentation

As an option, management and monitoring reports can be developed as an interactive electronic document to provide the reader access to enhanced graphics and additional material. Prior to developing an interactive report, stakeholder input should be considered.

While the report itself should be a stand-alone document presenting the latest round of monitoring data, interactive text and figures can also be presented on an accompanying CD to concisely present monitoring data collected over time.

For the Administrative Record or Site File, include a complete bookmarked PDF of the document on the CD.

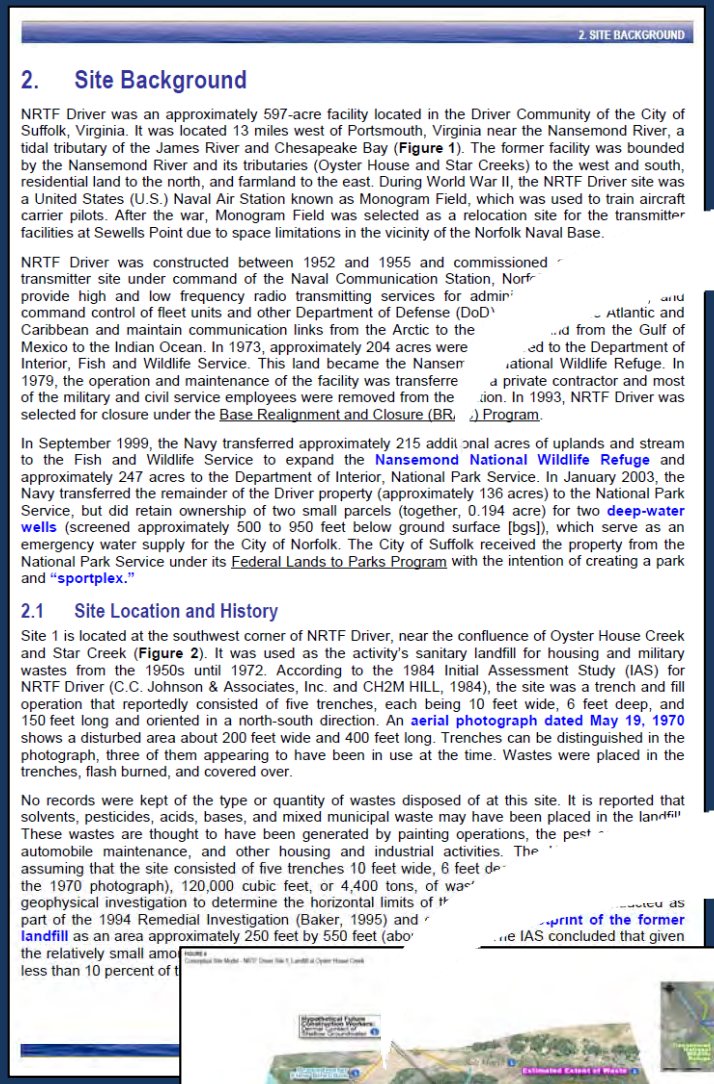
Some tips for consideration for developing an interactive report include:

- Bold blue text can be used to indicate a link to more specific or in-depth information on a particular topic (e.g., pertinent pages from a cited report).
- Icons can be used in figures and tables to identify a link to additional information (e.g., historic data tables, soil boring logs).
- Back buttons can be set to return the reader to their previous view of the document when links are used.

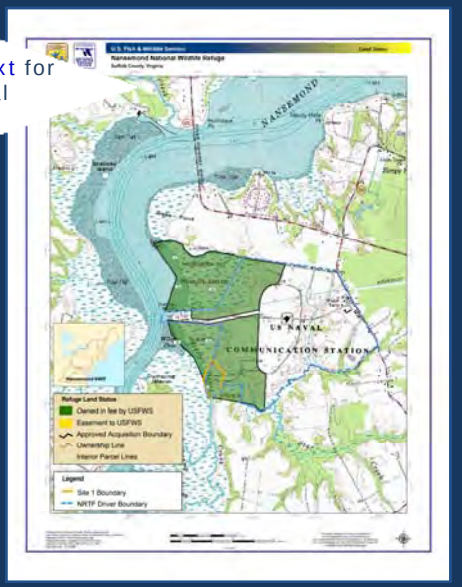
References should offer the reader the detail necessary to easily identify the referenced or linked information, for example: title/author/date, section number, page numbers, and Administrative Record numbers (where appropriate).

Document View

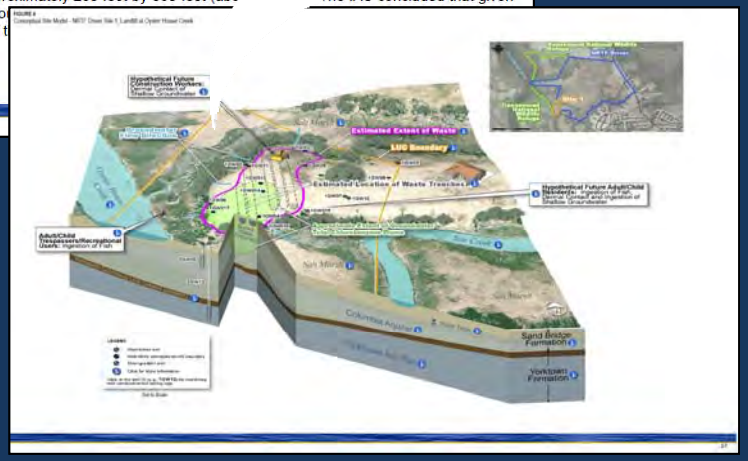
Additional Information



Click on bold blue text for links to additional information



Click on icons to view linked information



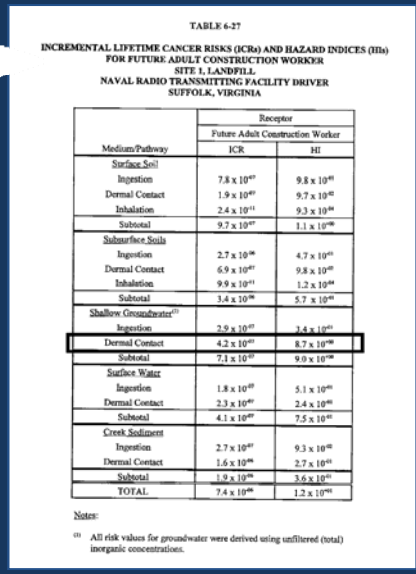


TABLE 6-27

INCREMENTAL LIFETIME CANCER RISKS (ICRs) AND HAZARD INDICES (HIs) FOR FUTURE ADULT CONSTRUCTION WORKER
SITE 1, LANDFILL
NAVAL RADIO TRANSMITTING FACILITY DRIVER
SUFFOLK, VIRGINIA

Medium/Pathway	Receptor: Future Adult Construction Worker ICR	HI
Surface Soil		
Ingestion	7.8 x 10^-07	9.8 x 10^-01
Dermal Contact	1.9 x 10^-07	9.7 x 10^-02
Inhalation	2.4 x 10^-11	9.3 x 10^-04
Subtotal	9.7 x 10^-07	1.1 x 10^-00
Subsurface Soils		
Ingestion	2.7 x 10^-06	4.7 x 10^-01
Dermal Contact	6.9 x 10^-07	9.8 x 10^-02
Inhalation	9.9 x 10^-11	1.2 x 10^-04
Subtotal	3.4 x 10^-06	5.7 x 10^-01
Shallow Groundwater[1]		
Ingestion	2.9 x 10^-07	3.4 x 10^-01
Dermal Contact	4.2 x 10^-07	8.7 x 10^-02
Subtotal	7.1 x 10^-07	9.0 x 10^-02
Surface Water		
Ingestion	1.8 x 10^-07	5.1 x 10^-01
Dermal Contact	2.3 x 10^-07	2.4 x 10^-02
Subtotal	4.1 x 10^-07	7.5 x 10^-02
Creek Sediment		
Ingestion	2.7 x 10^-07	9.3 x 10^-02
Dermal Contact	1.6 x 10^-06	2.7 x 10^-01
Subtotal	1.9 x 10^-06	3.6 x 10^-01
TOTAL	7.4 x 10^-06	1.2 x 10^-01

Notes:

(1) All risk values for groundwater were derived using unfiltered (total) inorganic concentrations.

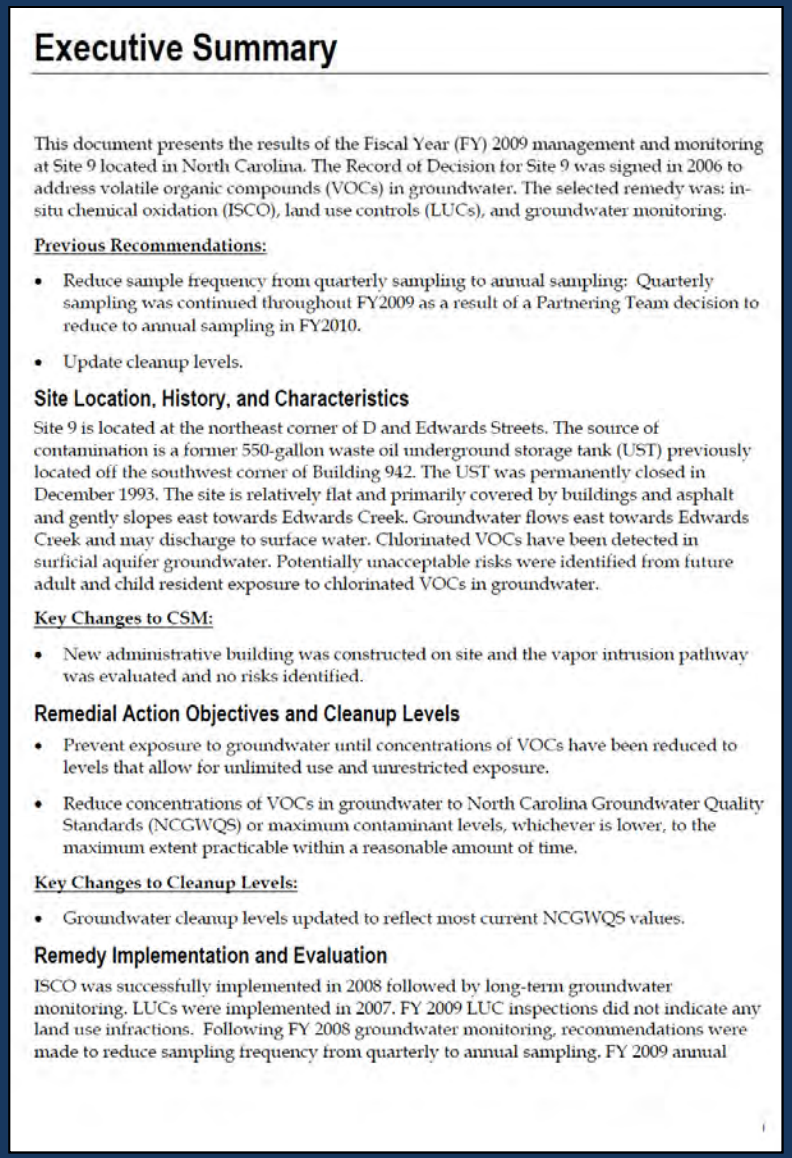
Executive Summary

Document Content

The Executive Summary should capture the key recommendations and changes to the Conceptual Site Model and monitoring approach. Concisely summarize current management approach and the findings and recommendations based on monitoring event(s). Consider a summary table to present report highlights.

Be sure to include the rationale for previous recommendations that were not fully implemented.

Document View



Executive Summary

This document presents the results of the Fiscal Year (FY) 2009 management and monitoring at Site 9 located in North Carolina. The Record of Decision for Site 9 was signed in 2006 to address volatile organic compounds (VOCs) in groundwater. The selected remedy was: in-situ chemical oxidation (ISCO), land use controls (LUCs), and groundwater monitoring.

Previous Recommendations:

- Reduce sample frequency from quarterly sampling to annual sampling: Quarterly sampling was continued throughout FY2009 as a result of a Partnering Team decision to reduce to annual sampling in FY2010.
- Update cleanup levels.

Site Location, History, and Characteristics

Site 9 is located at the northeast corner of D and Edwards Streets. The source of contamination is a former 550-gallon waste oil underground storage tank (UST) previously located off the southwest corner of Building 942. The UST was permanently closed in December 1993. The site is relatively flat and primarily covered by buildings and asphalt and gently slopes east towards Edwards Creek. Groundwater flows east towards Edwards Creek and may discharge to surface water. Chlorinated VOCs have been detected in surficial aquifer groundwater. Potentially unacceptable risks were identified from future adult and child resident exposure to chlorinated VOCs in groundwater.

Key Changes to CSM:

- New administrative building was constructed on site and the vapor intrusion pathway was evaluated and no risks identified.

Remedial Action Objectives and Cleanup Levels

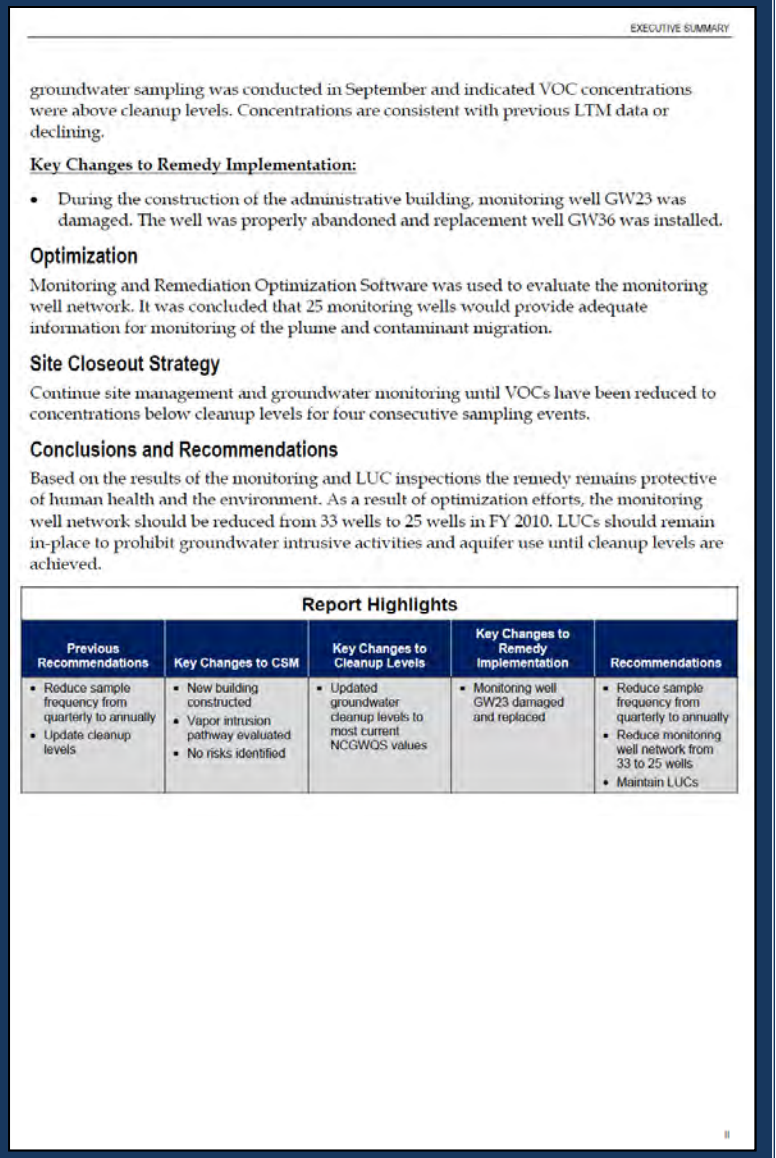
- Prevent exposure to groundwater until concentrations of VOCs have been reduced to levels that allow for unlimited use and unrestricted exposure.
- Reduce concentrations of VOCs in groundwater to North Carolina Groundwater Quality Standards (NCGWQS) or maximum contaminant levels, whichever is lower, to the maximum extent practicable within a reasonable amount of time.

Key Changes to Cleanup Levels:

- Groundwater cleanup levels updated to reflect most current NCGWQS values.

Remedy Implementation and Evaluation

ISCO was successfully implemented in 2008 followed by long-term groundwater monitoring. LUCs were implemented in 2007. FY 2009 LUC inspections did not indicate any land use infractions. Following FY 2008 groundwater monitoring, recommendations were made to reduce sampling frequency from quarterly to annual sampling. FY 2009 annual



groundwater sampling was conducted in September and indicated VOC concentrations were above cleanup levels. Concentrations are consistent with previous LTM data or declining.

Key Changes to Remedy Implementation:

- During the construction of the administrative building, monitoring well GW23 was damaged. The well was properly abandoned and replacement well GW36 was installed.

Optimization

Monitoring and Remediation Optimization Software was used to evaluate the monitoring well network. It was concluded that 25 monitoring wells would provide adequate information for monitoring of the plume and contaminant migration.

Site Closeout Strategy

Continue site management and groundwater monitoring until VOCs have been reduced to concentrations below cleanup levels for four consecutive sampling events.

Conclusions and Recommendations

Based on the results of the monitoring and LUC inspections the remedy remains protective of human health and the environment. As a result of optimization efforts, the monitoring well network should be reduced from 33 wells to 25 wells in FY 2010. LUCs should remain in-place to prohibit groundwater intrusive activities and aquifer use until cleanup levels are achieved.

Report Highlights

Previous Recommendations	Key Changes to CSM	Key Changes to Cleanup Levels	Key Changes to Remedy Implementation	Recommendations
• Reduce sample frequency from quarterly to annually • Update cleanup levels	• New building constructed • Vapor intrusion pathway evaluated • No risks identified	• Updated groundwater cleanup levels to most current NCGWQS values	• Monitoring well GW23 damaged and replaced	• Reduce sample frequency from quarterly to annually • Reduce monitoring well network from 33 to 25 wells • Maintain LUCs

Introduction

Document Content

This section is intended to provide the reader an introduction and the objectives of the report. The introduction should include:

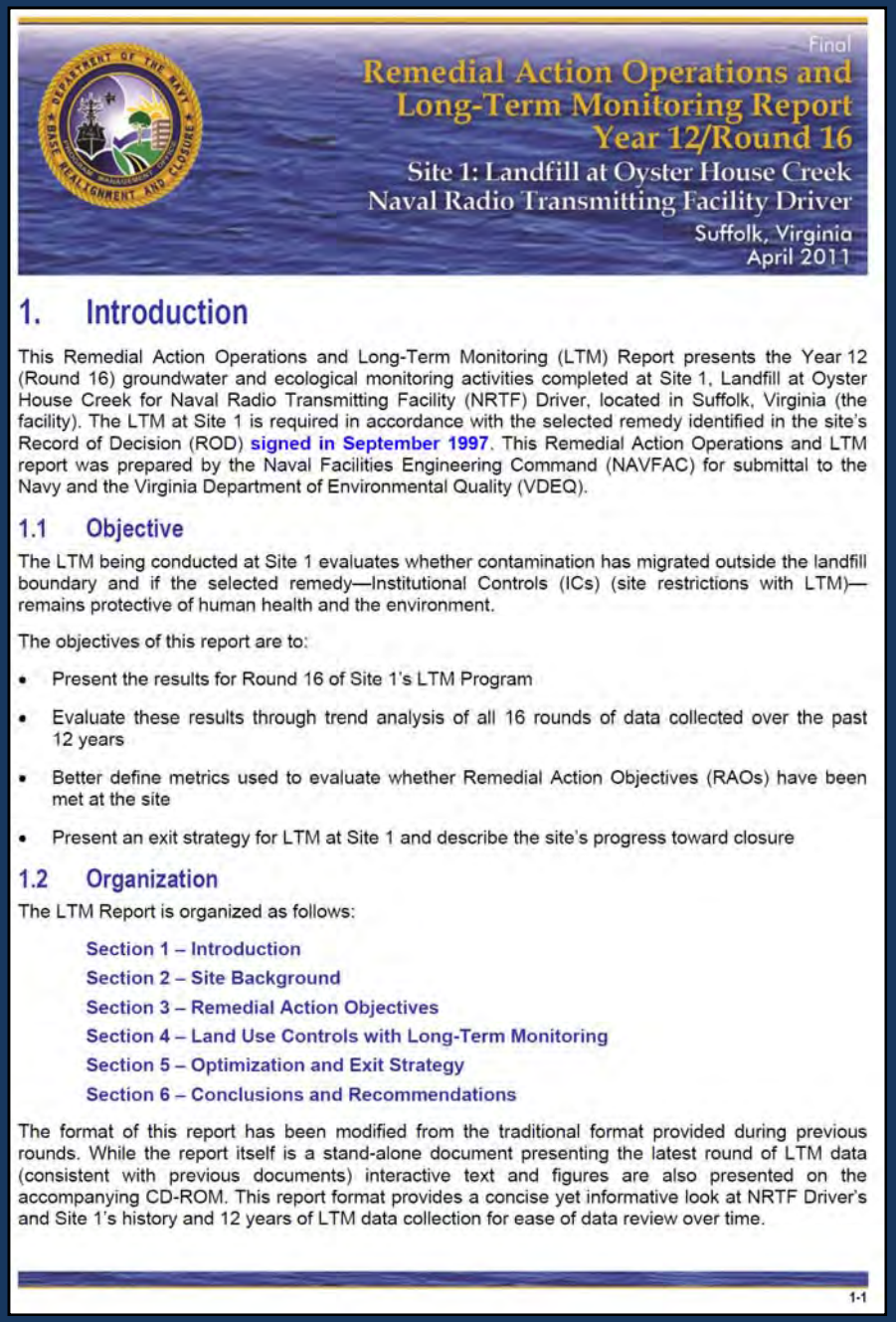
- Report Title
- Date and Round of Sampling
- Site and Facility Name
- Applicable Decision Document(s)
- Lead Agency and Stakeholders

The objectives of the management and monitoring program should be included, along with the specific objectives of the report. Report objectives to consider:

- Provide an update on the status of remedy implementation
- Present Trend Analysis
- Evaluate progress toward meeting Remedial Action Objectives and site closeout
- Present conclusions and recommendations

Document organization should be listed and will familiarize the reader with the layout and features of the report. Include section numbers and titles.

Document View



Final

Remedial Action Operations and Long-Term Monitoring Report Year 12/Round 16

Site 1: Landfill at Oyster House Creek
Naval Radio Transmitting Facility Driver

Suffolk, Virginia
April 2011

1. Introduction

This Remedial Action Operations and Long-Term Monitoring (LTM) Report presents the Year 12 (Round 16) groundwater and ecological monitoring activities completed at Site 1, Landfill at Oyster House Creek for Naval Radio Transmitting Facility (NRTF) Driver, located in Suffolk, Virginia (the facility). The LTM at Site 1 is required in accordance with the selected remedy identified in the site's Record of Decision (ROD) **signed in September 1997**. This Remedial Action Operations and LTM report was prepared by the Naval Facilities Engineering Command (NAVFAC) for submittal to the Navy and the Virginia Department of Environmental Quality (VDEQ).

1.1 Objective

The LTM being conducted at Site 1 evaluates whether contamination has migrated outside the landfill boundary and if the selected remedy—Institutional Controls (ICs) (site restrictions with LTM)—remains protective of human health and the environment.

The objectives of this report are to:

- Present the results for Round 16 of Site 1's LTM Program
- Evaluate these results through trend analysis of all 16 rounds of data collected over the past 12 years
- Better define metrics used to evaluate whether Remedial Action Objectives (RAOs) have been met at the site
- Present an exit strategy for LTM at Site 1 and describe the site's progress toward closure

1.2 Organization

The LTM Report is organized as follows:

Section 1 – Introduction
Section 2 – Site Background
Section 3 – Remedial Action Objectives
Section 4 – Land Use Controls with Long-Term Monitoring
Section 5 – Optimization and Exit Strategy
Section 6 – Conclusions and Recommendations

The format of this report has been modified from the traditional format provided during previous rounds. While the report itself is a stand-alone document presenting the latest round of LTM data (consistent with previous documents) interactive text and figures are also presented on the accompanying CD-ROM. This report format provides a concise yet informative look at NRTF Driver's and Site 1's history and 12 years of LTM data collection for ease of data review over time.

1-1

Additional Information

Interactive Management and Monitoring Report

If an interactive management and monitoring report is developed, this section should include discussions on how to use the interactive CD, the special features in the report, and some minor trouble shooting.

Site Location, History, and Characteristics

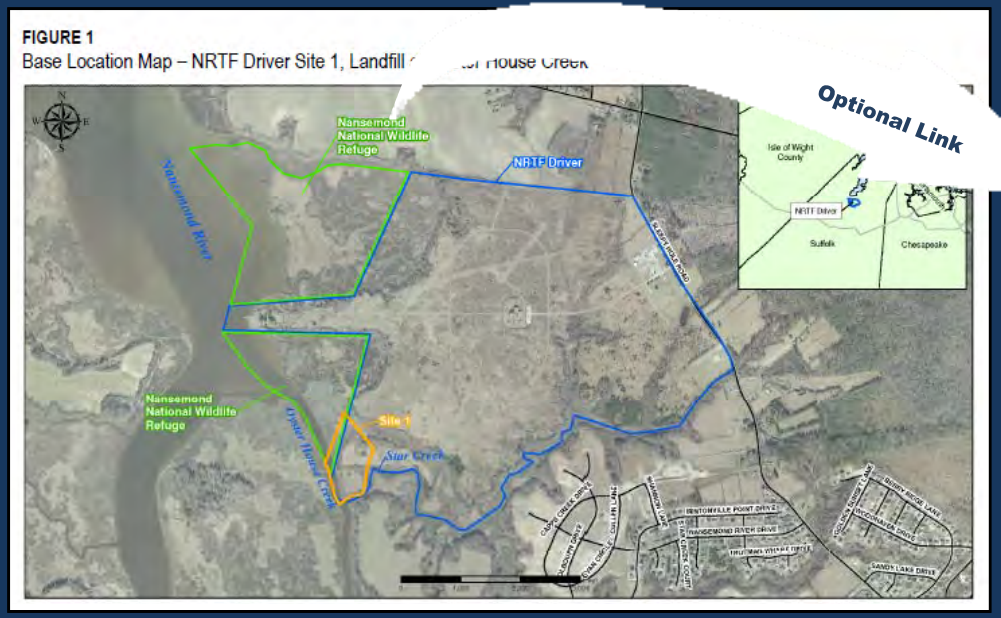
Document Content

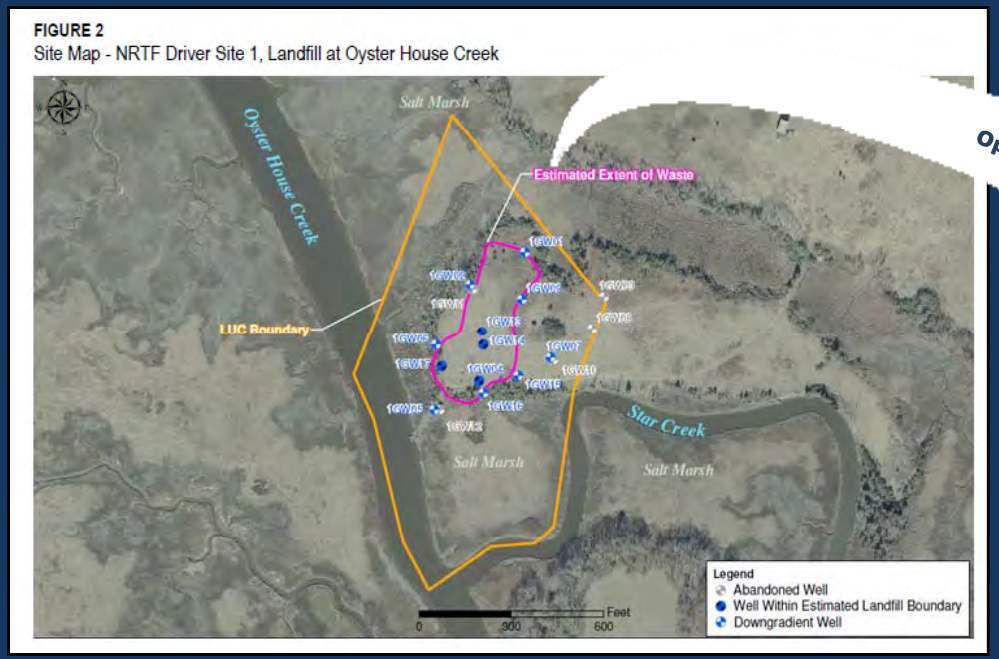
This section should provide an overview of the facility and site background. Consider including a summary with the following information:

- Name, location, and size of the facility and site
- Map showing the relationship between the site, facility, and surrounding area
- Former, current, and future use of the site
- Maps showing features pertinent to the site and remedy implementation (e.g., extent of filling operations, plume extent, land use controls, etc.)
- Geological and hydrogeological characteristics
- Regulatory programs and drivers for actions at the site

This information can be summarized in a narrative with embedded site specific maps, links to supporting documents, and other sources of information. Reformulate key facts and graphics from historical reports as copying and pasting can lead to extraneous information.

Document View





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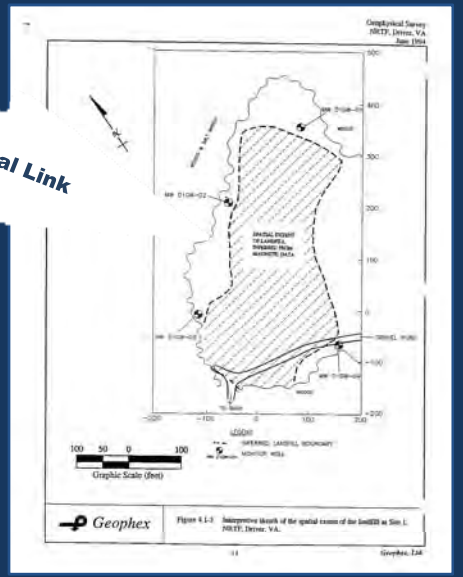


Conceptual Site Model

Document Content

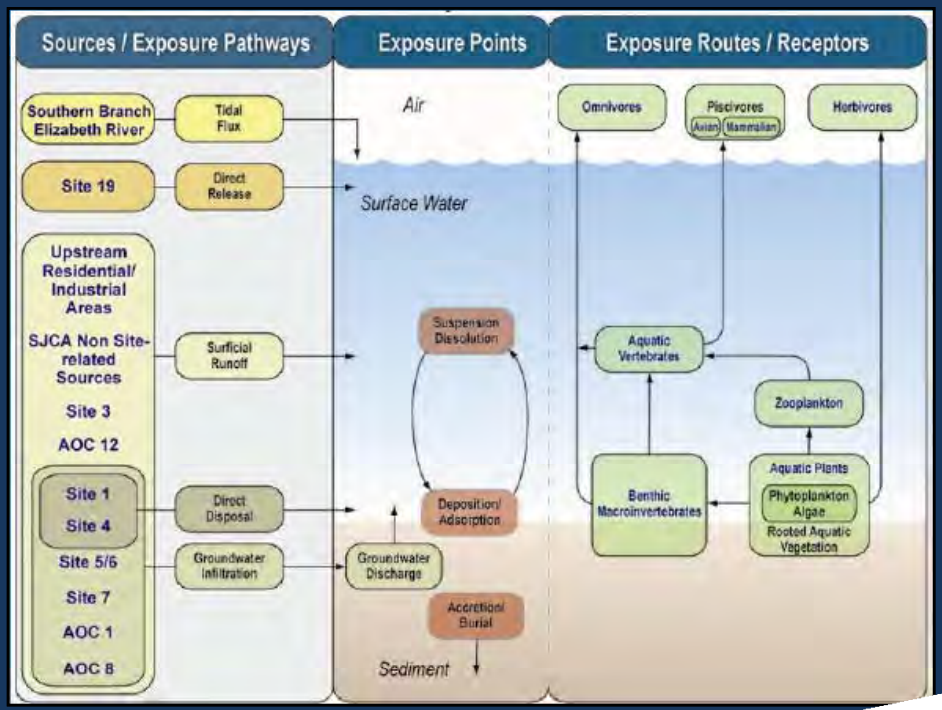
A Conceptual Site Model (CSM) should be presented to include the following:

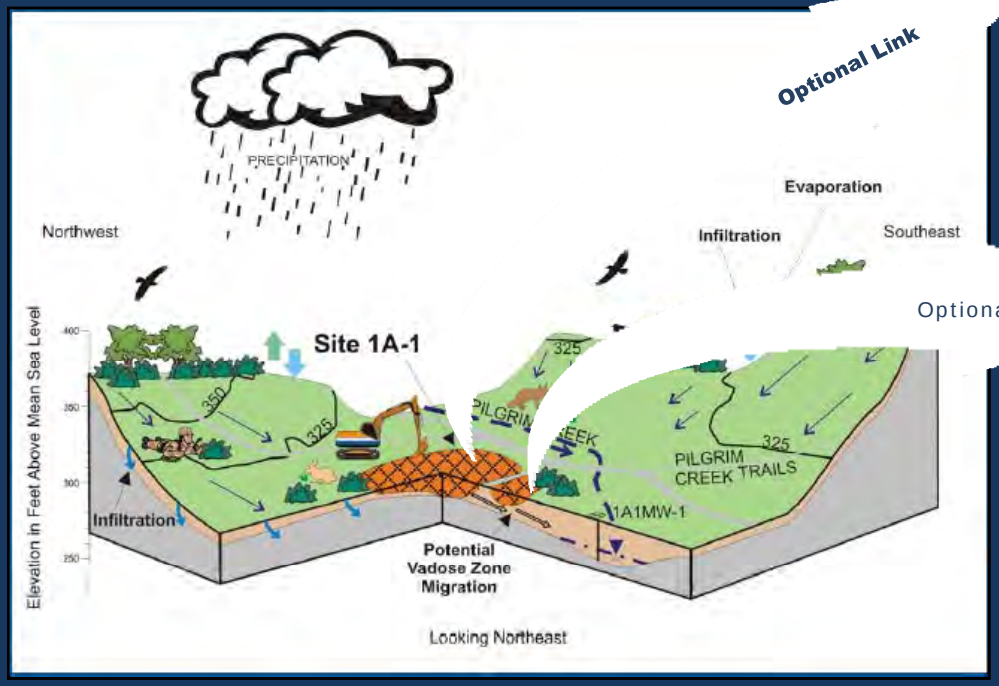
- Site layout
- Hydrogeologic setting
- Source area(s) and contaminated media
- Fate and transport mechanisms
- Exposure pathways
- Potential current and future receptors

A graphic CSM is preferred, but the level of detail required will vary depending on site conditions. Simpler CSMs can be developed by Remedial Project Managers or contractors, while more complex CSMs with detail and modeling information may need to be prepared by contractors. Additionally, for complex sites, multiple CSMs may need to be developed to fully communicate the site conditions.

Because the CSM is the key to aid in understanding why the remedy is effectively meeting goals and how it might impact future actions at the site, it should be referenced throughout the remainder of the site management and monitoring report.

Document View





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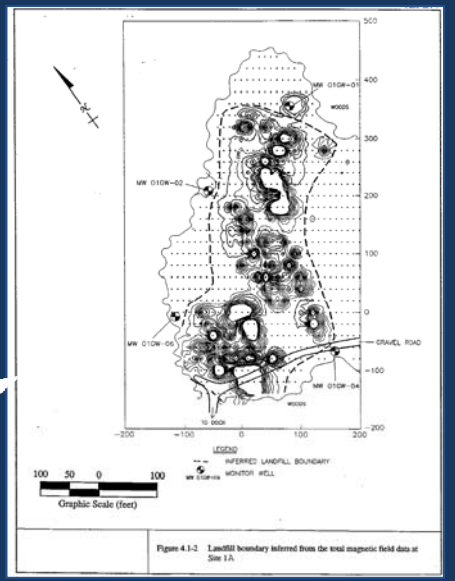


Optional Link

Excavation Area (after fill placement, grading, and top soil placement)

Conceptual Site Model contd.

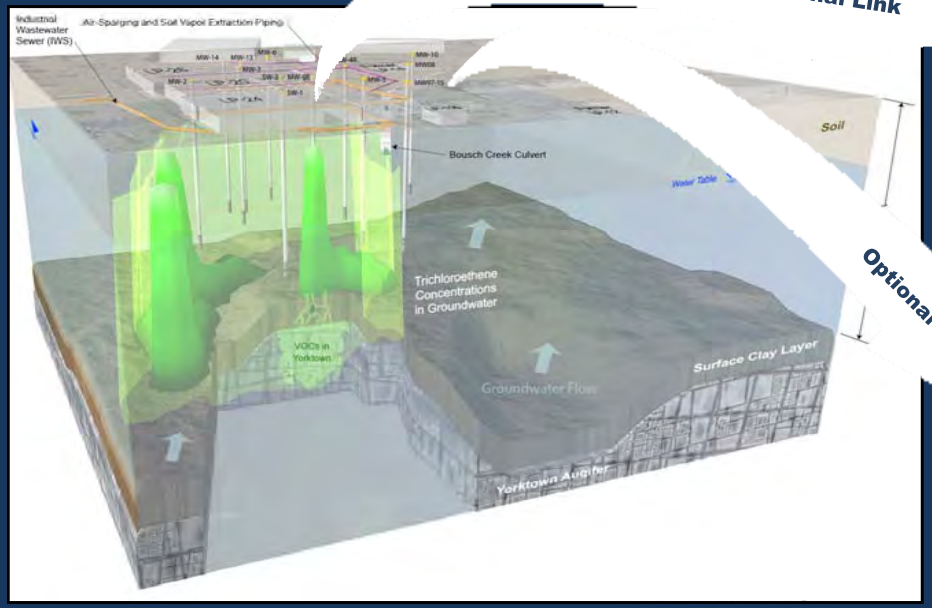
Document Content

If the site is complex, a greater level of detail may be necessary to demonstrate source materials, subsurface hydrogeology, and the lateral and vertical extent and magnitude of contamination. For example, at a chlorinated solvent site, if a Membrane Interface Probe (MIP) investigation was conducted to delineate the lateral and vertical extent of contamination, consider using the data to present a 3-dimensional (3-D) plume.

If appropriate, interactive links can be used to show the past, present, and future conditions at the site by linking to more detailed information [e.g., actual site photos, soil boring logs, geophysical surveys, 3-D modeling, receptor information, MIP logs and models, vapor intrusion conceptual site models (CSMs), historical CSMs, etc.].

Document View

Optional Link



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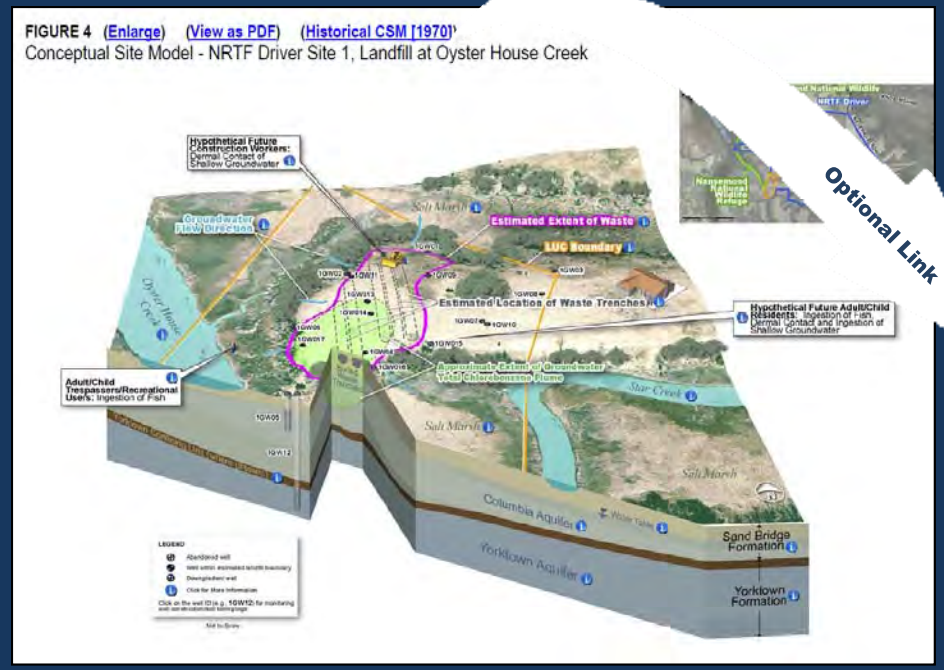

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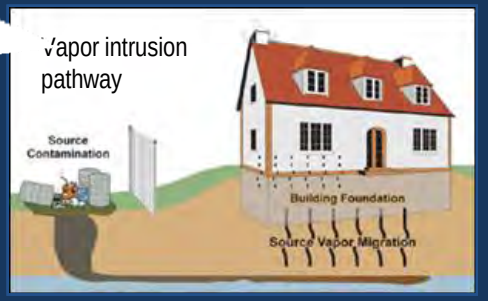
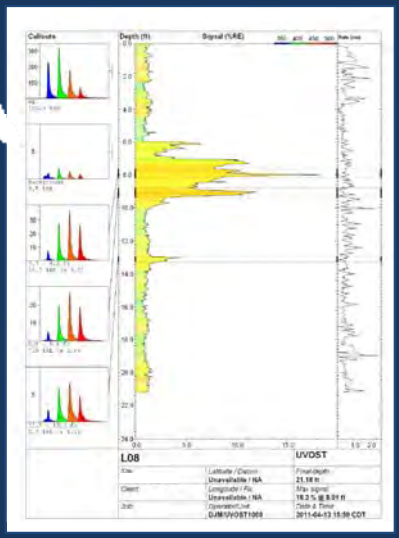
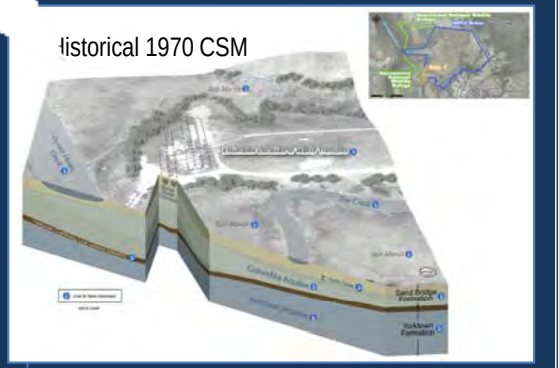






Previous Investigations and Decisions

Document Content

Discussions of previous investigations and actions (including enforcement activities) relevant to the management and monitoring report should be included in this section. Text and/or a summary table can be used to present previous investigations and actions including:

- Report title and date
- Objective(s) of the investigation/ action
- Activities conducted
- Key findings
- Conclusions and recommendations
- Administrative Record number (where applicable)

Similar tables may have been previously generated as part of the Record of Decision (ROD) and can be revised to incorporate any post-ROD actions. This table should be continually updated for inclusion in future documents, such as Five-Year Reviews.

Document View

4. SITE 3 LTM

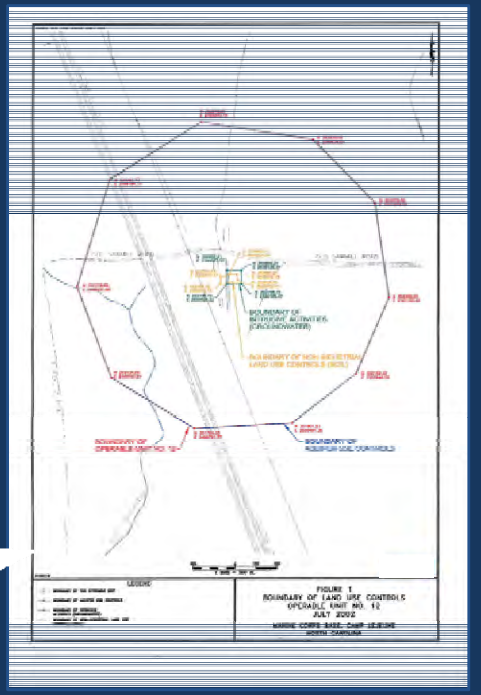
TABLE 4-1
Site 3 - Previous Investigations and Remedial Actions

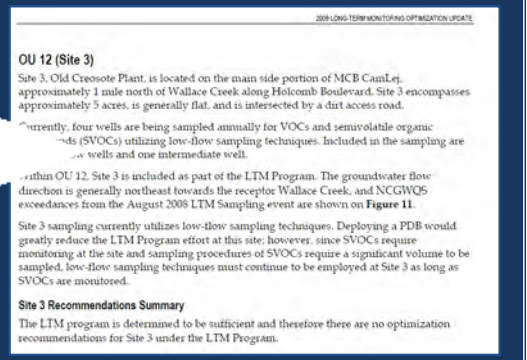
Pre-ROD Previous Investigation	Date	Activities	Admin. Record No.
Initial Assessment Study (IAS) (WAR)	1983	Site 3 was identified as a waste disposal site; however, no further assessment was recommended. USEPA requested an additional investigation to determine whether hazardous substances were present.	001511
Site Inspection (Halliburton/NUS)	1991	Soil, groundwater, and sediment were evaluated. SVOCs, particularly polycyclic aromatic hydrocarbons (PAHs), were detected in the surface soil (0 to 2 ft) near the reported location of the former sawmill and at the treatment area. PAHs were detected in the surface and subsurface (15 to 17 ft bgs) soil, and groundwater within the surficial aquifer.	000331
Remedial Investigation (RI) (Baker)	1996	Evaluated the nature and extent of contamination. VOCs (particularly fuel constituents) and SVOCs (primarily PAHs) were detected in groundwater within the surficial and Castle Hayne aquifers. SVOCs were identified in both the surface and subsurface soil, particularly within the creosote treatment area. The human health risk assessment (HHRA) identified potential risks to future residential children and adults due to exposure to the following SVOCs in groundwater: benzo(a)pyrene, benzo(a)anthracene, dibenzofuran, phenanthrene, and acenapthalene.	001699 and 001700
FS (Baker)	1996	Following an evaluation of remedial alternatives for both soil and groundwater, the following two-part alternative was selected: Source removal with onsite biological treatment of PAH-contaminated subsurface soils. Monitored natural attenuation (MNA) with LUCs for groundwater.	001721
ROD (Baker)	1997	Established **Remedial Action Objectives (RAOs)** and defined the selected remedy. The RAOs were: – Prevent leaching of PAH contaminants from subsurface soil to the groundwater. – Remediate subsurface soil and shallow groundwater. – Prevent exposure to contaminated groundwater	001753
Post-ROD Previous Investigations	**Date**	**Activities**	**Admin. Record No.**
LTM	1998	LTM monitoring begins	NA
Treatability Study (Baker)	1998	Biological treatme … inated subsurface soil was tested. The st… at biological treatment was not effective.	NA
Amended ROD (DoN)	2000	Based o… ults of the 1998 Treatability Study, the remedy was ar… to remove biological treatment of soils. Soil excav… with offsite disposal was chosen to address source remo… t this site.	NA
Non-Time Critical Removal Action (NTCRA) (Shaw)	2000	Appro… mately 3,295 tons of PAH-contaminated soil was removed from S…te 3 and disposed of offsite.	NA
Land-Use Control Implementation Plan (LUCIP) (DoN)	2001	The **LUC** objectives are to: – Prohibit intrusive activities that could potentially e… to impacted groundwater. – Prohibit the withdrawal and any use of conta… ed groundwater, except for environmental moni… ng, for the aquifers within 1,000 ft of the estimated ext… of impacted groundwater.	
LTM Optimization Update	2009	Site 3 **LTM program determined sufficient to meet objectives**.	NA
Current LTM Activities	2010	Annual groundwater sampling from four monitoring wells for VOC and SVOC analyses were increased to quarterly sampling for one year to reassess the site for possible closeout.	NA

Optional Link

Optional Link

Additional Information





2009 LONG-TERM MONITORING OPTIMIZATION UPDATE

OU 12 (Site 3)

Site 3, Old Creosote Plant, is located on the main side portion of MCB CamLej, approximately 1 mile north of Wallace Creek along Holcomb Boulevard. Site 3 encompasses approximately 5 acres, is generally flat, and is intersected by a dirt access road.

…urrently, four wells are being sampled annually for VOCs and semivolatile organic …ds (SVOCs) utilizing low-flow sampling techniques. Included in the sampling are …w wells and one intermediate well.

…ithin OU 12, Site 3 is included as part of the LTM Program. The groundwater flow direction is generally northeast towards the receptor Wallace Creek, and NCGWQS exceedances from the August 2008 LTM Sampling event are shown on **Figure 11**.

Site 3 sampling currently utilizes low-flow sampling techniques. Deploying a PDB would greatly reduce the LTM Program effort at this site; however, since SVOCs require monitoring at the site and sampling procedures of SVOCs require a significant volume to be sampled, low-flow sampling techniques must continue to be employed at Site 3 as long as SVOCs are monitored.

Site 3 Recommendations Summary

The LTM program is determined to be sufficient and therefore there are no optimization recommendations for Site 3 under the LTM Program.

Remedial Action Objectives and Cleanup Levels

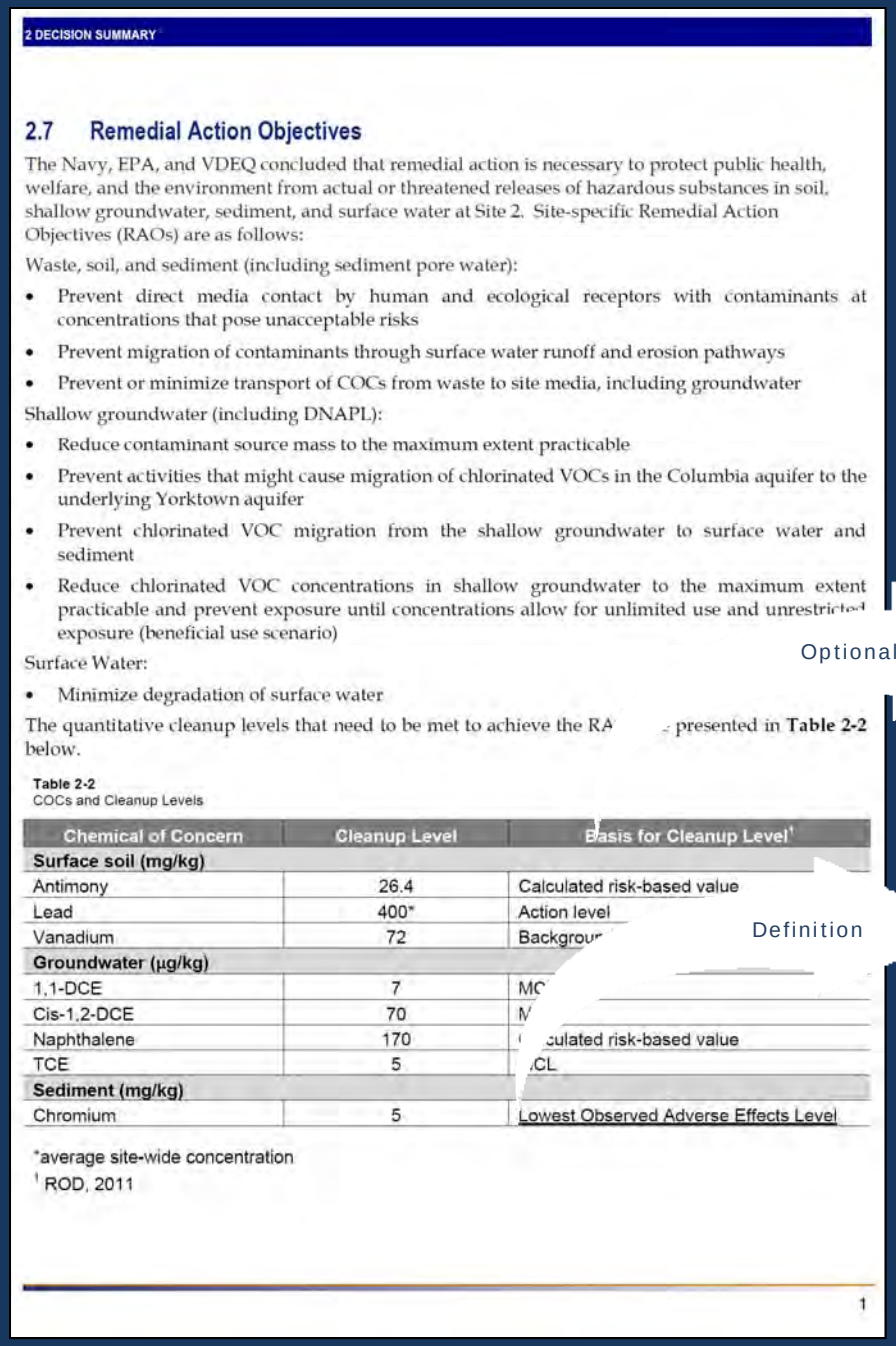
Document Content

This section should list site-specific remedial action objectives (RAOs) and cleanup levels to provide an understanding of why site management and monitoring is being conducted and the goals to reach site closeout. For sites that do not have specific cleanup levels, consider listing any screening criteria established for evaluating site conditions. Refer to the Record of Decision (ROD) and/or other post-ROD documentation to identify the most up-to-date site-specific RAOs, long–term management objectives and/or clean-up levels.

For sites where historical cleanup levels were not developed, or need updating to reflect current regulatory requirements, include rationale for establishment of or changes to cleanup levels. For considerations on how to document post-ROD changes refer to the Conclusions and Recommendations section.

A summary table can be used to list the constituents of concern by each media requiring action, respective cleanup levels, and a basis for the cleanup levels.

Document View



2 DECISION SUMMARY

2.7 Remedial Action Objectives

The Navy, EPA, and VDEQ concluded that remedial action is necessary to protect public health, welfare, and the environment from actual or threatened releases of hazardous substances in soil, shallow groundwater, sediment, and surface water at Site 2. Site-specific Remedial Action Objectives (RAOs) are as follows:

Waste, soil, and sediment (including sediment pore water):

- Prevent direct media contact by human and ecological receptors with contaminants at concentrations that pose unacceptable risks
- Prevent migration of contaminants through surface water runoff and erosion pathways
- Prevent or minimize transport of COCs from waste to site media, including groundwater

Shallow groundwater (including DNAPL):

- Reduce contaminant source mass to the maximum extent practicable
- Prevent activities that might cause migration of chlorinated VOCs in the Columbia aquifer to the underlying Yorktown aquifer
- Prevent chlorinated VOC migration from the shallow groundwater to surface water and sediment
- Reduce chlorinated VOC concentrations in shallow groundwater to the maximum extent practicable and prevent exposure until concentrations allow for unlimited use and unrestricted exposure (beneficial use scenario)

Surface Water:

- Minimize degradation of surface water

The quantitative cleanup levels that need to be met to achieve the RA[illegible] presented in **Table 2-2** below.

Table 2-2
COCs and Cleanup Levels

Chemical of Concern	Cleanup Level	Basis for Cleanup Level[1]
Surface soil (mg/kg)		
Antimony	26.4	Calculated risk-based value
Lead	400*	Action level
Vanadium	72	Backgrou[illegible]
Groundwater (µg/kg)		
1,1-DCE	7	MC[illegible]
Cis-1,2-DCE	70	M[illegible]
Naphthalene	170	[illegible]culated risk-based value
TCE	5	[illegible]CL
Sediment (mg/kg)		
Chromium	5	Lowest Observed Adverse Effects Level

*average site-wide concentration
[1] ROD, 2011

1

Additional Information

Optional Link

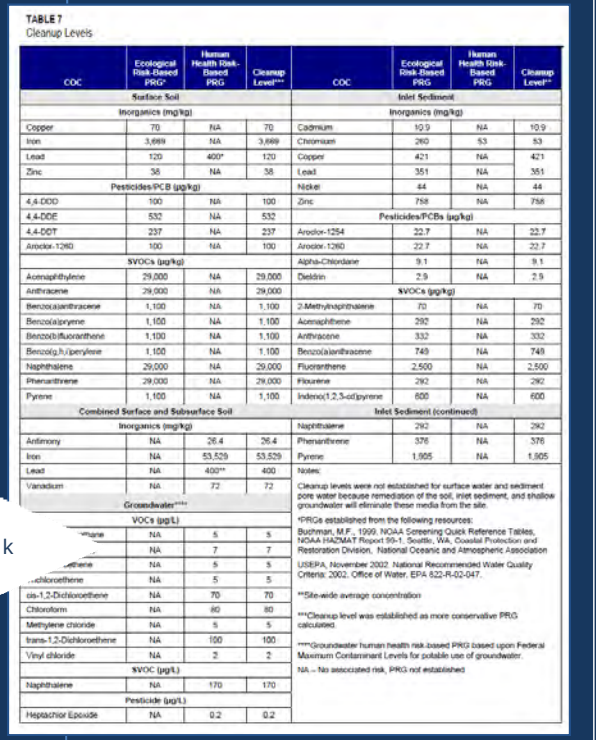


TABLE 7
Cleanup Levels

COC	Ecological Risk-Based PRG*	Human Health Risk-Based PRG	Cleanup Level**
Surface Soil			
Inorganics (mg/kg)			
Copper	70	NA	70
Iron	3,669	NA	3,669
Lead	120	400*	120
Zinc	38	NA	38
Pesticides/PCB (µg/kg)			
4,4-DDD	100	NA	100
4,4-DDE	532	NA	532
4,4-DDT	237	NA	237
Aroclor-1260	100	NA	100
SVOCs (µg/kg)			
Acenaphthylene	29,000	NA	29,000
Anthracene	29,000	NA	29,000
Benzo(a)anthracene	1,100	NA	1,100
Benzo(a)pyrene	1,100	NA	1,100
Benzo(b)fluoranthene	1,100	NA	1,100
Benzo(g,h,i)perylene	1,100	NA	1,100
Naphthalene	29,000	NA	29,000
Phenanthrene	29,000	NA	29,000
Pyrene	1,100	NA	1,100
Combined Surface and Subsurface Soil			
Inorganics (mg/kg)			
Antimony	NA	26.4	26.4
Iron	NA	53,529	53,529
Lead	NA	400**	400
Vanadium	NA	72	72
Groundwater***			
VOCs (µg/L)			
[illegible]hane	NA	5	5
[illegible]	NA	7	7
[illegible]ethene	NA	5	5
[illegible]chloroethene	NA	5	5
cis-1,2-Dichloroethene	NA	70	70
Chloroform	NA	80	80
Methylene chloride	NA	5	5
trans-1,2-Dichloroethene	NA	100	100
Vinyl chloride	NA	2	2
SVOC (µg/L)			
Naphthalene	NA	170	170
Pesticide (µg/L)			
Heptachlor Epoxide	NA	0.2	0.2

COC	Ecological Risk-Based PRG	Human Health Risk-Based PRG	Cleanup Level**
Inlet Sediment			
Inorganics (mg/kg)			
Cadmium	10.9	NA	10.9
Chromium	260	53	53
Copper	421	NA	421
Lead	351	NA	351
Nickel	44	NA	44
Zinc	758	NA	758
Pesticides/PCBs (µg/kg)			
Aroclor-1254	22.7	NA	22.7
Aroclor-1260	22.7	NA	22.7
Alpha-Chlordane	9.1	NA	9.1
Dieldrin	2.9	NA	2.9
SVOCs (µg/kg)			
2-Methylnaphthalene	70	NA	70
Acenaphthene	292	NA	292
Anthracene	332	NA	332
Benzo(a)anthracene	749	NA	749
Fluoranthene	2,500	NA	2,500
Fluorene	292	NA	292
Indeno(1,2,3-cd)pyrene	600	NA	600
Inlet Sediment (continued)			
Naphthalene	292	NA	292
Phenanthrene	376	NA	376
Pyrene	1,905	NA	1,905

Notes:
Cleanup levels were not established for surface water and sediment pore water because remediation of the soil, inlet sediment, and shallow groundwater will eliminate these media from the site.

*PRGs established from the following resources:
Buchman, M.F., 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1. Seattle, WA. Coastal Protection and Restoration Division, National Oceanic and Atmospheric Association

USEPA, November 2002. National Recommended Water Quality Criteria: 2002. Office of Water. EPA 822-R-02-047.

**Site-wide average concentration

***Cleanup level was established as more conservative PRG calculated.

****Groundwater human health risk-based PRG based upon Federal Maximum Contaminant Levels for potable use of groundwater.

NA – No associated risk, PRG not established

Definition

Lowest Observed Adverse Effects Level: Lowest concentration or [illegible]ount of a substance, found by experiment or observation, which causes an adverse alteration of morphology, functional capacity, growth, development, or life span of a target organism distinguishable from normal (control) organisms of the same species and strain under defined conditions of exposure.

Remedy Implementation and Evaluation

Document Content

The remedy implementation and evaluation section should introduce the selected remedy including a brief description of each remedy component and expected outcome. A summary table may be used to describe how remedy components meet remedial action objectives and/or long-term management objectives, and include metrics for evaluating their success. This should provide an understanding of whether each remedy component will be effective in achieving the expected outcome. Expected outcomes may include implementation of subsequent treatment train technologies or contingency remedies.

Subsections should describe the ongoing implementation of each remedy component and the current status of the site. In this document, examples are provided for active treatment, land use controls, and a monitoring program.

Document View

2—DECISION SUMMARY

TABLE 6
Expected Outcomes

Risk		RAO	Remedy Component	Metric	Expected Outcomes	
Human Health	Ecological					
Shallow Groundwater						
Ingestion of and dermal contact with groundwater under future potable use scenario; inhalation of vapors in shallow groundwater in an open excavation for future construction workers	No exposure pathway	Reduce concentrations of COCs in the source area and the downgradient plume to remediation goals (MCLs) through treatment to the maximum extent practicable within a reasonable amount of time	ERD	Monitor shallow groundwater COC concentrations to confirm reduction of total COC concentrations to below 500 µg/L and plume stabilization	Elimination of source area and prevention of downgradient migration of plume	Removal of LUCs
			Performance Monitoring			
			LTM	Monitor shallow groundwater COC concentrations to confirm the natural degradation process until concentrations are at or below cleanup levels (MCLs)	Achieve unlimited use and unrestricted exposure	
		Prevent exposure to Site 11a groundwater and groundwater emissions until concentrations of COCs have been reduced to levels that allow for unlimited use and unrestricted exposure	LUCs	Per... below their respective cleanup levels (MCLs)	Removal of LU...	
			LTM	Monitor shallow groundwater COC concentrations to evaluate the potential for vapor intrusion until concentrations are at or below cleanup levels (MCLs)		

Additional Information

Optional Link

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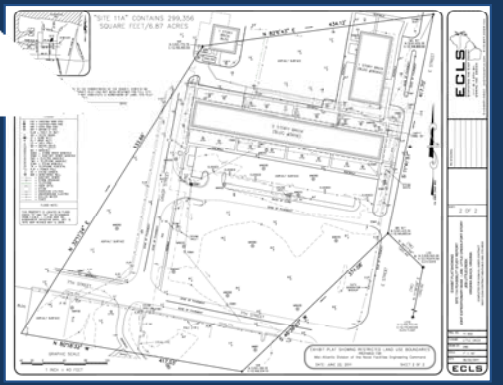


Land Use Controls

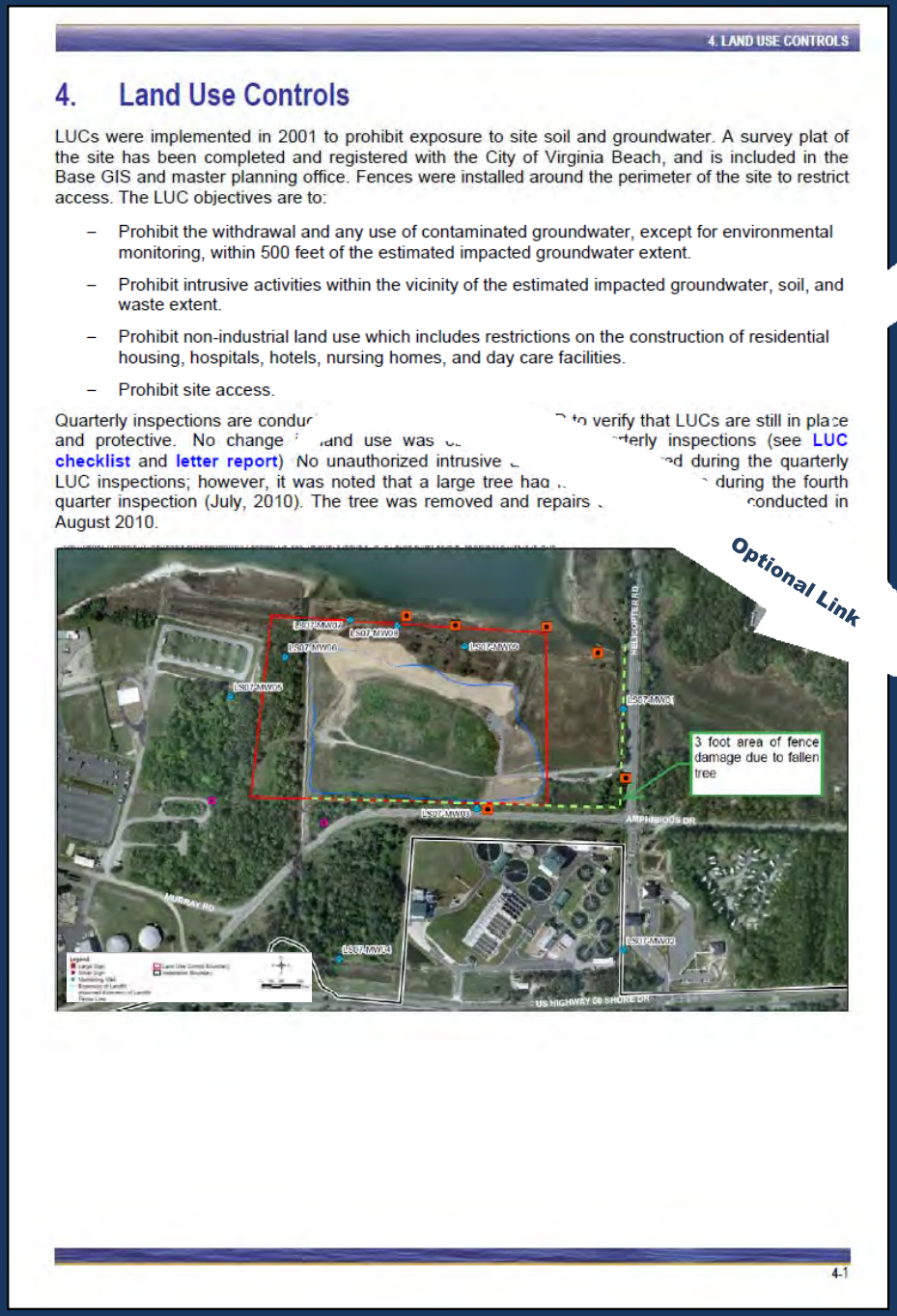
Document Content

This section should describe the land use controls (LUCs) and LUC objectives. Include documentation of the following that occurred during the reporting period:

- Base operations – any activities that have occurred on the site in support of the base mission (e.g., utility repair, general construction, etc.)
- Site inspections – dates of inspection, infractions noted, and corrective measures taken
- Site operations and maintenance (O&M) – activities related to O&M (e.g., fence repair, sign replacement, soil cover repair, etc.)

Consider the use of figures, LUC checklists, letters, memos, plats, etc., when applicable. LUC checklists should be developed and agreed upon by regulatory stakeholders, prior to use.

Document View



4. LAND USE CONTROLS

4. Land Use Controls

LUCs were implemented in 2001 to prohibit exposure to site soil and groundwater. A survey plat of the site has been completed and registered with the City of Virginia Beach, and is included in the Base GIS and master planning office. Fences were installed around the perimeter of the site to restrict access. The LUC objectives are to:

- Prohibit the withdrawal and any use of contaminated groundwater, except for environmental monitoring, within 500 feet of the estimated impacted groundwater extent.
- Prohibit intrusive activities within the vicinity of the estimated impacted groundwater, soil, and waste extent.
- Prohibit non-industrial land use which includes restrictions on the construction of residential housing, hospitals, hotels, nursing homes, and day care facilities.
- Prohibit site access.

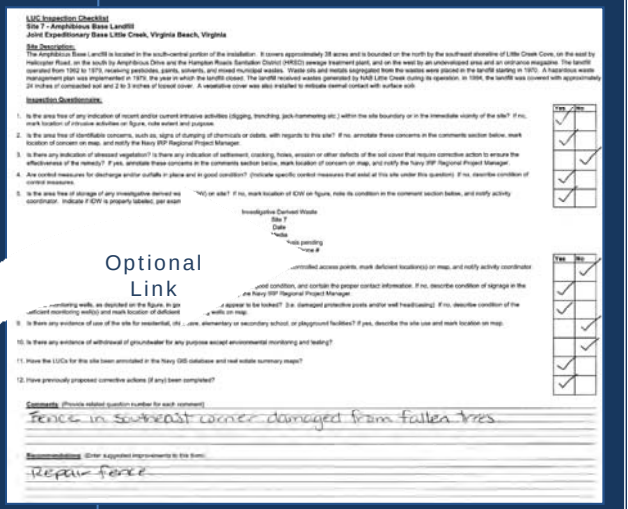
Quarterly inspections are conduc[illegible] to verify that LUCs are still in place and protective. No change [illegible]and use was o[illegible]rterly inspections (see LUC checklist and letter report). No unauthorized intrusive [illegible]ed during the quarterly LUC inspections; however, it was noted that a large tree had [illegible] during the fourth quarter inspection (July, 2010). The tree was removed and repairs [illegible]conducted in August 2010.

Optional Link

4-1

Additional Information

Optional Link



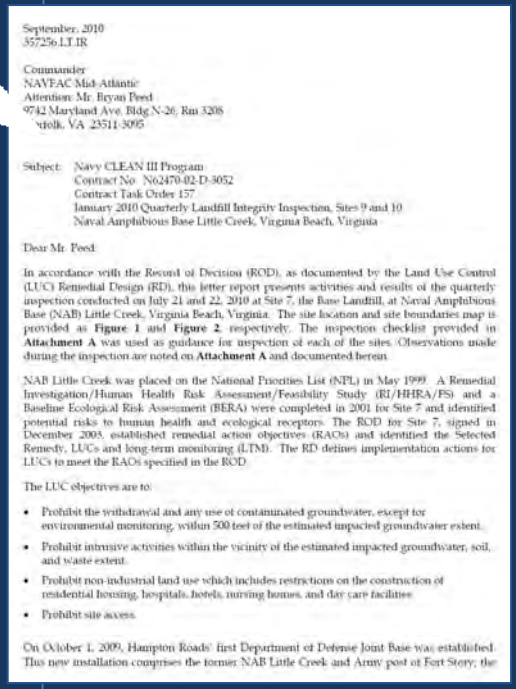
LUC Inspection Checklist
Site 7 - Amphibious Base Landfill
Joint Expeditionary Base Little Creek, Virginia Beach, Virginia

Site Description:

Inspection Questionnaire:

Fence in southeast corner damaged from fallen tree

Repair fence



September, 2010
357256.LT.IR

Commander
NAVFAC Mid-Atlantic
Attention: Mr. Bryan Peed
9742 Maryland Ave, Bldg N-26, Rm 3208
Norfolk, VA 23511-3095

Subject: Navy CLEAN III Program
Contract No. N62470-02-D-3052
Contract Task Order 157
January 2010 Quarterly Landfill Integrity Inspection, Sites 9 and 10
Naval Amphibious Base Little Creek, Virginia Beach, Virginia

Dear Mr. Peed:

In accordance with the Record of Decision (ROD), as documented by the Land Use Control (LUC) Remedial Design (RD), this letter report presents activities and results of the quarterly inspection conducted on July 21 and 22, 2010 at Site 7, the Base Landfill, at Naval Amphibious Base (NAB) Little Creek, Virginia Beach, Virginia. The site location and site boundaries map is provided as **Figure 1** and **Figure 2**, respectively. The inspection checklist provided in **Attachment A** was used as guidance for inspection of each of the sites. Observations made during the inspection are noted on **Attachment A** and documented herein.

NAB Little Creek was placed on the National Priorities List (NPL) in May 1999. A Remedial Investigation/Human Health Risk Assessment/Feasibility Study (RI/HHRA/FS) and a Baseline Ecological Risk Assessment (BERA) were completed in 2001 for Site 7 and identified potential risks to human health and ecological receptors. The ROD for Site 7, signed in December 2003, established remedial action objectives (RAOs) and identified the Selected Remedy, LUCs and long-term monitoring (LTM). The RD defines implementation actions for LUCs to meet the RAOs specified in the ROD.

The LUC objectives are to:

- Prohibit the withdrawal and any use of contaminated groundwater, except for environmental monitoring, within 500 feet of the estimated impacted groundwater extent.
- Prohibit intrusive activities within the vicinity of the estimated impacted groundwater, soil, and waste extent.
- Prohibit non-industrial land use which includes restrictions on the construction of residential housing, hospitals, hotels, nursing homes, and day care facilities.
- Prohibit site access.

On October 1, 2009, Hampton Roads' first Department of Defense Joint Base was established. This new installation comprises the former NAB Little Creek and Army post of Fort Story; the

Active Treatment

Document Content

This section should describe remedy implementation and on-going treatment, where appropriate. Provide a summary of site-specific information including:

- Dates of treatment
- Amount and type of substrate injected
- Operating parameters
- Maintenance requirements (routine and/or repairs)
- Document any equipment failures
- Contamination treated/removed
- Enhancements to bio-remediation
- Treatment train and contingency remedies

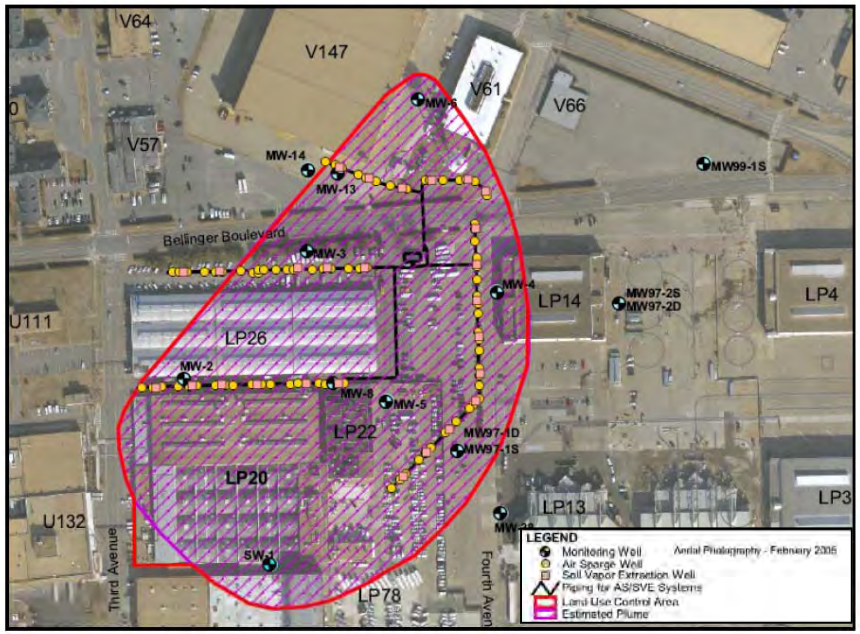
Identify any performance objectives that measure the operational efficiency and suitability of the active remedy. These objectives provide the decision-making steps on when to transition to another technology or optimize a treatment train, ultimately leading to a closeout strategy for the treatment system.

Document View

5.2 Active Treatment

Remedial action began at LP-20 in February 2010 with the installation of 78 air sparge (AS) we[illegible] soil vapor extraction (SVE) wells, and baseline groundwater sampling (**Figure 4-3**). B[illegible]eline groundwater samples were collected from 15 newly installed monitoring wells. F[illegible]llowing completion of the baseline sampling the AS/SVE system was initiated in November 2010. The sy[illegible] is currently running at 180 cfm. Since initiation, the system has removed approximately 1[illegible] pounds of cumulative VOCs from groundwater, averaging approximately 20 pounds per month.

Figure 4-3 Layout of the AS/SVE System, Monitoring Wells and Groundwater Plume



5.3 Monitoring Objectives - Data Quality Objectives

5.3.1 Problem Definition and Goals

Past operations at LP-20 resulted in VOCs being released to groundwater. Remedial action is currently underway to treat VOCs in groundwater. During treatment, groundwater must be monitored to confirm that contaminants are not migrating offsite at unacceptable levels, determine if contaminate concentrations are decreasing, and determine when cleanup goals have been met.

5.3.2 Study Boundaries

Groundwater of interest is in the Columbia aquifer. The Columbia aquifer is vertically bound by the underlying clays of the Yorktown confining unit. Groundwater samples will be collected from the Columbia aquifer. The horizontal boundary and monitoring well network are based upon the current plume configuration.

1

Additional Information

Optional Link

Optional Link

Monitoring Program: Data Quality Objectives

Document Content

This section includes the data quality objectives (DQOs) for the monitoring program and should clearly state:

- Problem definition
- Goals/environmental questions to be answered (e.g., monitored natural attenuation, release beyond the point of compliance from a landfill, ensuring that the plume is not migrating off-site, vapor intrusion monitoring, or remedy component transition)
- Study boundaries
- Project action limits

The DQOs were likely established as the decision documents were developed and remedy chosen. Revisit these objectives to ensure that goals outlined adequately address the metrics for remedy components and expected outcomes.

Document View

5.3.1 Monitoring Objectives – Data Quality Objectives

5.3.1.1 Problem Definition and Goals

Past operations at Site 4 resulted in the release of chlorinated VOCs to the soil in the vicinity of Building 106. A removal action conducted removed the source of the contamination, leaving the secondary (groundwater) contamination. Groundwater is monitored to confirm that contaminants are not migrating off site at unacceptable levels, concentrations are decreasing naturally, and progress in meeting cleanup goals.

5.3.1.2 Study Boundaries

The contaminated groundwater is within the shallow and intermediate aquifers at Site 4 displays the vertical and horizontal groundwater contamination study boundaries.

5.3.1.3 Project Action Limits

Project Action Limits (PALs) for groundwater concentrations for the COCs ar d in **Table 5-1**.

TABLE 5-1
Site 4 Project Action Limits

Constituent of Concern (COC)	Project Action Limit (µg/L)
Tetrachloroethene (PCE)	5
1,1-DCE	7
TCE	5
VC	2
cis-1,2-DCE	70
trans-1,2-DCE	100

Note: PAL is federal MCL.

When collecting groundwater samples, groundwater quality parameters are collected to verify monitoring well stabilization prior to sampling. Groundwater quality parameters [turbidity, temperature, pH, conductivity, oxidation-reduction potential (ORP), salinity, and dissolved oxygen (DO)] are recorded every five minutes. Monitoring wells are purged until one well volume is removed and field parameters stabilize. Field parameters are considered stabilized when 3 consecutive measurements agree as follows:

- pH within 0.1 units
- temperature within 1 degree Celsius
- conductivity within 3 percent
- DO within 10 percent
- turbidity within 10 percent or as low as practicable given sampling conditions
- ORP within 10mV

Optional Link

Additional Information

SAP Worksheet #C11—Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

Participants from the Tier I Partnering Team (VDEQ, USEPA, Navy, and CH2M HILL) will use the data to evaluate overall remedy effectiveness with respect to plume containment and reduction of VOCs in the source area. Other technically focused disciplines within each organization may use the data as well. Chemists will use the data to evaluate overall data quality with respect to subcontracted laboratories and or changing chemical conditions in the aquifer. Engineers will use the data to evaluate the effectiveness of the remedial action and to make adjustments to the remedial action and the LTM plan as appropriate. Engineers may use the data in designing remedial systems in the future, and geologists may use the data to gain better understanding of aquifer conditions contributing to contaminant fate and transport mechanisms.

What are the Project Action Limits (PALs):

The action levels specified in the ROD are the MCLs unless concentrations over time ...dicate stabilized conditions and all parties (Navy, USEPA, and VDEQ) agree that ...ed VOCs have been removed to the extent practicable. The action limits for the ...s are listed in Worksheet #C10 (Table C1) and provided in Worksheet #C15-1.

The performance indication levels (PILs) for other chemicals/analytes are provided on Worksheet #C15-2. PILs for microbial sampling are provided on Worksheet #C15-3. Arsenic and ferrous iron will be analyzed because dissolution of these metals in the aquifer can occur when reducing conditions are induced by the remedy. Monitoring concentrations of these metals will help determine the efficacy of anaerobic biological activity, as well as the state of the aquifer. Other remedy performance indicators (e.g., MEE and TOC) will be monitored to evaluate geochemical conditions and the efficacy of the ERD remedy. Worksheets #C15-2 and #C15-3 include the rationale for sampling these performance indicators. Concentrations of remedy performance indicators will not be compared to risk-based screening criteria, but will be judge qualitatively and relative to site-specific conditions.

What will the data be used for?

The overall goals of LTM are to determine if the monitoring scheme for the site is appropriate, if the remedy being employed is effective, and if RAOs have been achieved. Should observations be made such that the data are unable to answer these questions, the monitoring will be modified accordingly. If results from the modified monitoring indicate that one or more of the goals are not being met or that the results against goals still cannot be assessed, the Partnering Team will discuss the remedy and monitoring plan.

Monitoring Program: Sampling and Analysis

Document Content

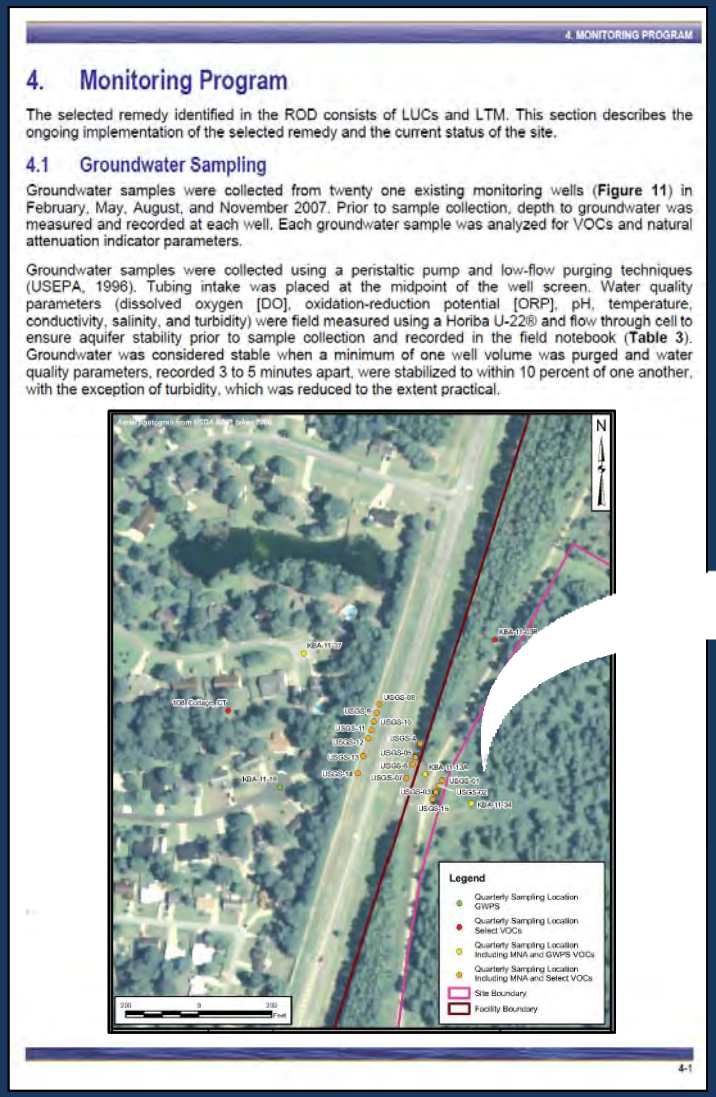
The sampling and analysis section should include the details of the monitoring program. A table can be used to summarize the following:

- Sample matrices
- Sample locations
- Sample methods
- Sample parameters
- Laboratory methods
- Laboratory requirements (e.g., Department of Defense Environmental Laboratory Accreditation Program accreditation, state certification, etc.)

A figure showing the study area and sample locations should also be provided. A table summarizing the sampling constituents by media should be included, if applicable.

Consistent sampling and laboratory analytical methods should be used to reduce data variability and increase data comparability within each monitoring event and over time.

Document View



4. MONITORING PROGRAM

4. Monitoring Program

The selected remedy identified in the ROD consists of LUCs and LTM. This section describes the ongoing implementation of the selected remedy and the current status of the site.

4.1 Groundwater Sampling

Groundwater samples were collected from twenty one existing monitoring wells (**Figure 11**) in February, May, August, and November 2007. Prior to sample collection, depth to groundwater was measured and recorded at each well. Each groundwater sample was analyzed for VOCs and natural attenuation indicator parameters.

Groundwater samples were collected using a peristaltic pump and low-flow purging techniques (USEPA, 1996). Tubing intake was placed at the midpoint of the well screen. Water quality parameters (dissolved oxygen [DO], oxidation-reduction potential [ORP], pH, temperature, conductivity, salinity, and turbidity) were field measured using a Horiba U-22® and flow through cell to ensure aquifer stability prior to sample collection and recorded in the field notebook (**Table 3**). Groundwater was considered stable when a minimum of one well volume was purged and water quality parameters, recorded 3 to 5 minutes apart, were stabilized to within 10 percent of one another, with the exception of turbidity, which was reduced to the extent practical.

4-1

4. Monitoring Program

Table 4.1 summarizes the current monitoring approach by media and constituents for the site. Specific sampling requirements are discussed in further detail in sections 4.1 and 4.2 of this report.

Table 4.1
Summary of Sampling Constituents by Media

Media	Analytes		
	Volatile Organic Compounds	Inorganics	Pesticides
Sediments	X		X
Groundwater	X	X	X
Fish Tissue			X

Optional Link

Additional Information

Sampling Location/Well ID – KBA-11-134						
Analyte	**Sampling Method**	**Freq-uency**	**Analyt-ical Method**	**Certifi-cation/ Calib-ration**	**PALs (µg/L)**	**Minimum PQLs (µg/L)**
Cis-1,2-DCE	Low flow	Annually	SW-846 8260B	ELAP	70	23
TCE	Low flow	Annually	SW-846 8260B	ELAP	5	1.7
VC	Low flow	Annually	SW-846 8260B	ELAP	2	0.7
Field Measurements Water Quality Parameters						
DO	Horiba / Chemets	Annually	NA	daily	NA	NA
ORP	Horiba	Annually	NA	daily	NA	NA
pH	Horiba	Annually	NA	daily	NA	NA
Temperature	Horiba	Annually	NA	daily	NA	NA
Conductivity	Horiba	Annually	NA	daily	NA	NA
Turbidity	Horiba / Turbidity meter	Annually	NA	daily	NA	NA
Monitored Natural Attenuation Indicators						
Nitrate	Low flow	Every 5 Years	USEPA 300.0	ELAP	NA	NA
Nitrite	Low flow	Every 5	USEPA	ELAP	NA	NA
				ELAP	NA	NA
				ELAP	NA	NA
				ELAP	NA	NA
				ELAP	NA	NA

ACLASS

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board/ACLASS
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Environment, Inc.
123 Main Street
Maintown, Maine 12345

has been assessed by ACLASS
and meets the requirements of

ISO/IEC 17025:2005 and DoD-ELAP

while demonstrating technical competence in the field(s) of

TESTING

Refer to the accompanying Scope(s) of Accreditation for information regarding the types of tests to which this accreditation applies.

ADE-1821
Certificate Number

ACLASS Approval

Certificate Valid: 10/23/2011-10/23/2013
Version No. 003 Issued: 12/08/2011

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated January 2009*).

Monitoring Program: Data Evaluation

Document Content

This section should clearly depict the results from the current monitoring event using text, summary tables, and figures. Depending on the data quality objectives (DQOs), it may also be helpful to include results from past monitoring efforts. For a stand-alone report present the current round of data and trend analysis of constituents of concern (COCs) over time. If appropriate, consider providing data from previous monitoring rounds as appendices or links.

The type of data analysis that is performed will be specific to the DQOs at the site and may include statistical trend analysis and/or comparison to performance metrics, cleanup goals, or cleanup levels. Data evaluation examples may include:

- At a landfill site with no COCs and groundwater monitoring at the point of compliance, consider a trend analysis of those data to identify if a release has occurred or demonstrate no release has occurred.
- For a groundwater remedy designed to reduce COC concentrations, include comparison to cleanup levels and trend analysis.

The subsequent data evaluation pages provide additional direction on presenting trend analysis, groundwater treatment, and monitored natural attenuation.

For historical data, Naval Installation Restoration Information Solution (NIRIS), the Navy's repository for analytical data, can be used.

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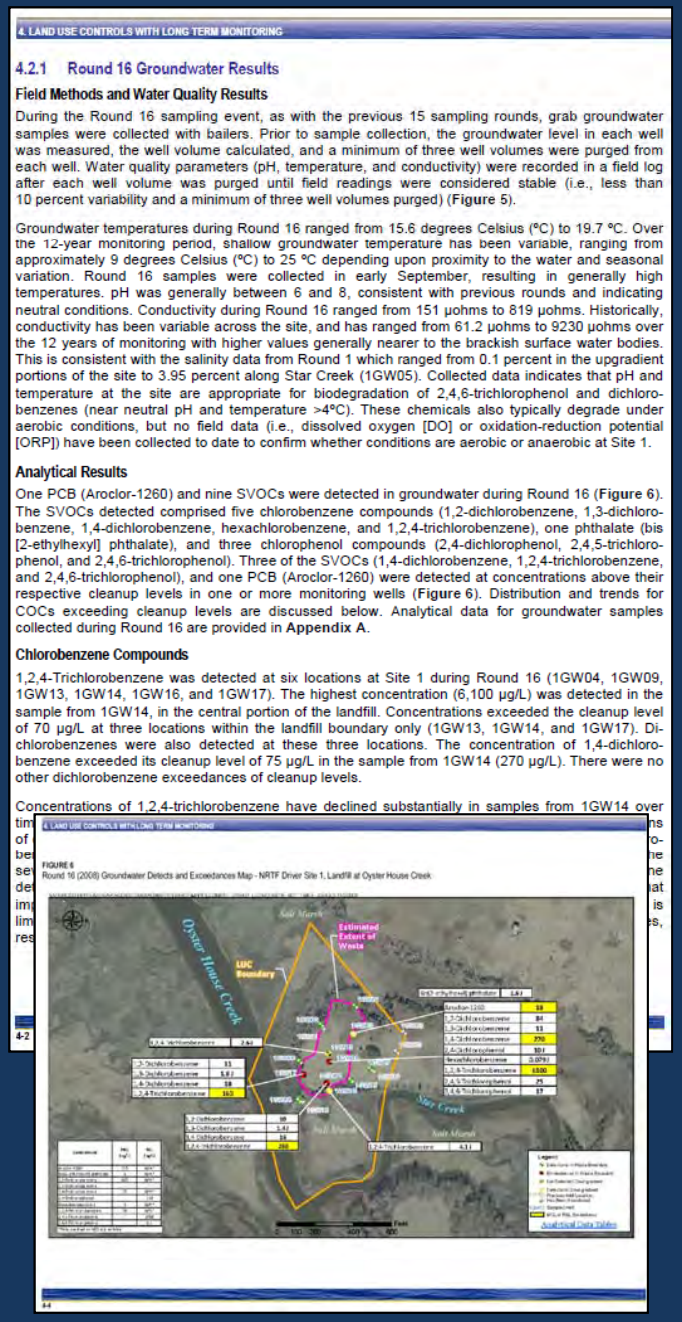


4. LAND USE CONTROLS WITH LONG TERM MONITORING

4.2.1 Round 16 Groundwater Results

Field Methods and Water Quality Results

During the Round 16 sampling event, as with the previous 15 sampling rounds, grab groundwater samples were collected with bailers. Prior to sample collection, the groundwater level in each well was measured, the well volume calculated, and a minimum of three well volumes were purged from each well. Water quality parameters (pH, temperature, and conductivity) were recorded in a field log after each well volume was purged until field readings were considered stable (i.e., less than 10 percent variability and a minimum of three well volumes purged) (**Figure** 5).

Groundwater temperatures during Round 16 ranged from 15.6 degrees Celsius (°C) to 19.7 °C. Over the 12-year monitoring period, shallow groundwater temperature has been variable, ranging from approximately 9 degrees Celsius (°C) to 25 °C depending upon proximity to the water and seasonal variation. Round 16 samples were collected in early September, resulting in generally high temperatures. pH was generally between 6 and 8, consistent with previous rounds and indicating neutral conditions. Conductivity during Round 16 ranged from 151 µohms to 819 µohms. Historically, conductivity has been variable across the site, and has ranged from 61.2 µohms to 9230 µohms over the 12 years of monitoring with higher values generally nearer to the brackish surface water bodies. This is consistent with the salinity data from Round 1 which ranged from 0.1 percent in the upgradient portions of the site to 3.95 percent along Star Creek (1GW05). Collected data indicates that pH and temperature at the site are appropriate for biodegradation of 2,4,6-trichlorophenol and dichlorobenzenes (near neutral pH and temperature >4°C). These chemicals also typically degrade under aerobic conditions, but no field data (i.e., dissolved oxygen [DO] or oxidation-reduction potential [ORP]) have been collected to date to confirm whether conditions are aerobic or anaerobic at Site 1.

Analytical Results

One PCB (Aroclor-1260) and nine SVOCs were detected in groundwater during Round 16 (**Figure** 6). The SVOCs detected comprised five chlorobenzene compounds (1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, hexachlorobenzene, and 1,2,4-trichlorobenzene), one phthalate (bis [2-ethylhexyl] phthalate), and three chlorophenol compounds (2,4-dichlorophenol, 2,4,5-trichlorophenol, and 2,4,6-trichlorophenol). Three of the SVOCs (1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and 2,4,6-trichlorophenol), and one PCB (Aroclor-1260) were detected at concentrations above their respective cleanup levels in one or more monitoring wells (**Figure** 6). Distribution and trends for COCs exceeding cleanup levels are discussed below. Analytical data for groundwater samples collected during Round 16 are provided in **Appendix A**.

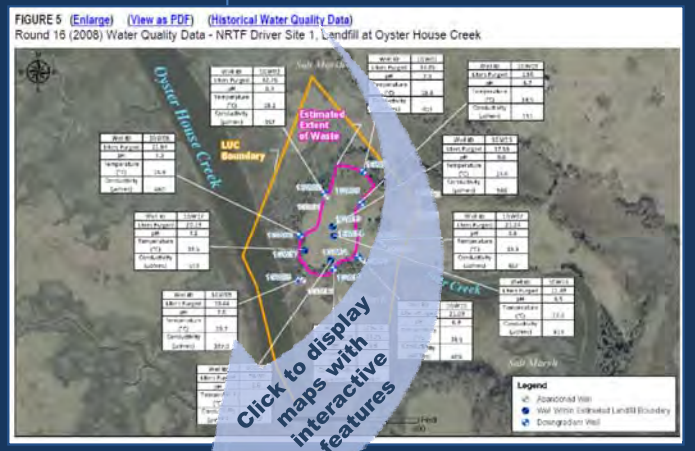
Chlorobenzene Compounds

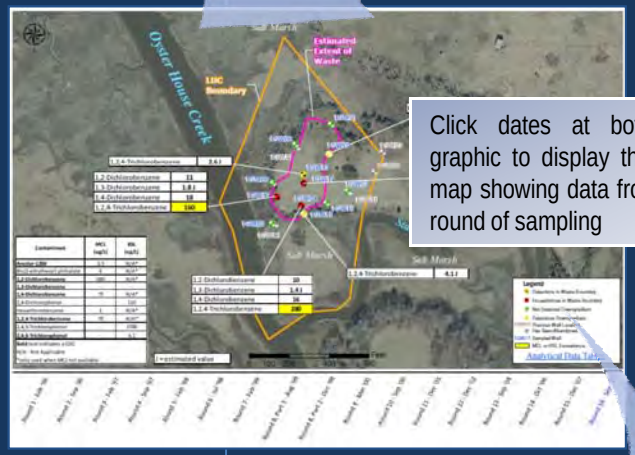
1,2,4-Trichlorobenzene was detected at six locations at Site 1 during Round 16 (1GW04, 1GW09, 1GW13, 1GW14, 1GW16, and 1GW17). The highest concentration (6,100 µg/L) was detected in the sample from 1GW14, in the central portion of the landfill. Concentrations exceeded the cleanup level of 70 µg/L at three locations within the landfill boundary only (1GW13, 1GW14, and 1GW17). Dichlorobenzenes were also detected at these three locations. The concentration of 1,4-dichlorobenzene exceeded its cleanup level of 75 µg/L in the sample from 1GW14 (270 µg/L). There were no other dichlorobenzene exceedances of cleanup levels.

Concentrations of 1,2,4-trichlorobenzene have declined substantially in samples from 1GW14 over

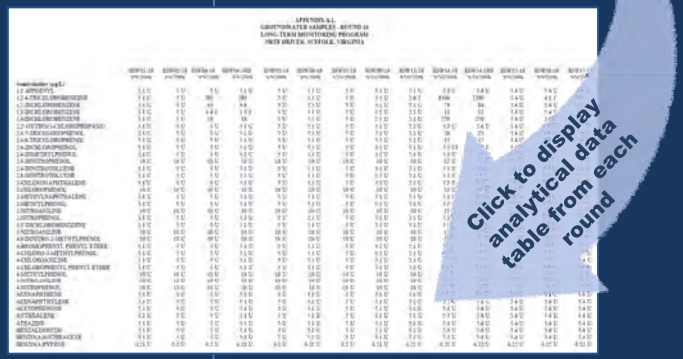
FIGURE 6
Round 16 (2008) Groundwater Detects and Exceedances Map - NRTF Driver Site 1, Landfill at Oyster House Creek

Additional Information





Click dates at bottom of graphic to display the same map showing data from each round of sampling



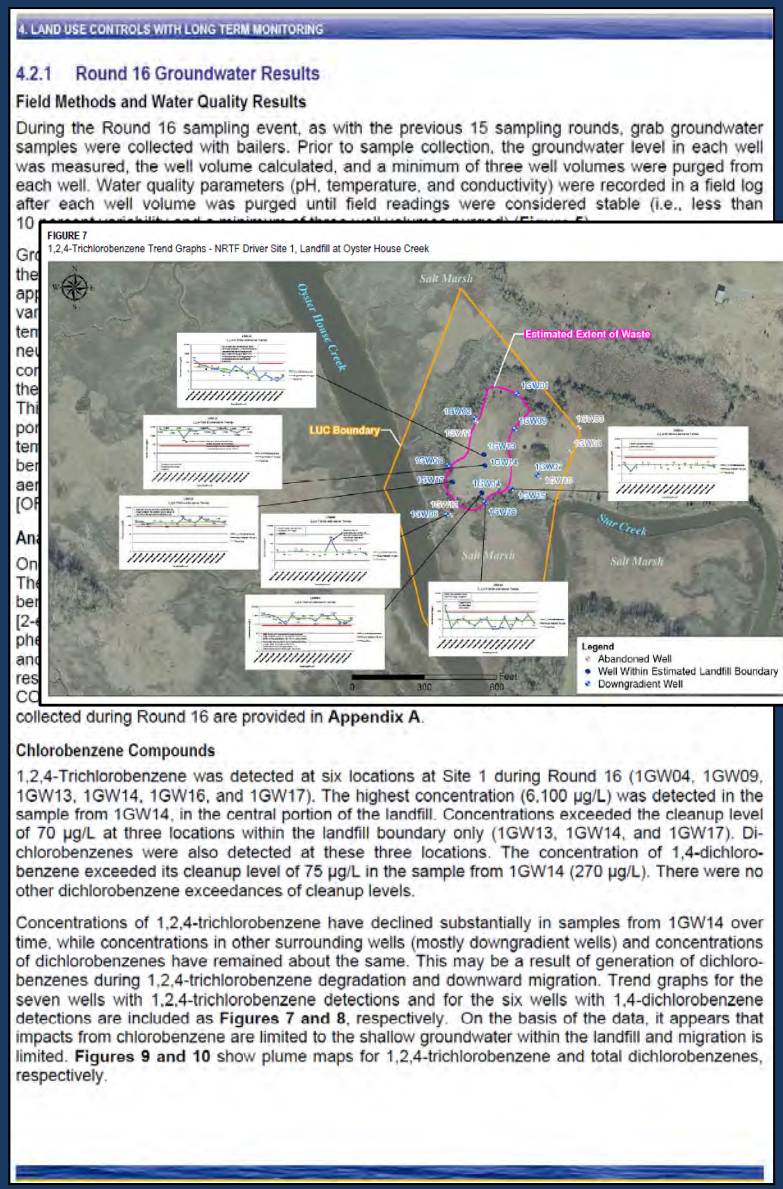
Data Evaluation: Trend Charts

Document Content

Trend charts should be used to document changes in the concentrations of constituents of concern over time. The charts should be evaluated to provide interpretations to give the reader a better understanding of what is going on at the site and for supporting the conclusions and recommendations. The key data evaluation elements to consider for trend charts are:

- Plot the cleanup level or other target endpoint on the trend graph for comparison
- Develop trend lines using statistical methods such as Regression Analysis (e.g., using Microsoft Excel 2003) or Mann Kendall Test
- Embed an explanation of the data shown on the trend to highlight conclusions as they relate to data quality objectives (e.g., slight downward trend, consistent over time, anomalous data point)

Document View



4. LAND USE CONTROLS WITH LONG TERM MONITORING

4.2.1 Round 16 Groundwater Results

Field Methods and Water Quality Results

During the Round 16 sampling event, as with the previous 15 sampling rounds, grab groundwater samples were collected with bailers. Prior to sample collection, the groundwater level in each well was measured, the well volume calculated, and a minimum of three well volumes were purged from each well. Water quality parameters (pH, temperature, and conductivity) were recorded in a field log after each well volume was purged until field readings were considered stable (i.e., less than 10

FIGURE 7
1,2,4-Trichlorobenzene Trend Graphs - NRTF Driver Site 1, Landfill at Oyster House Creek

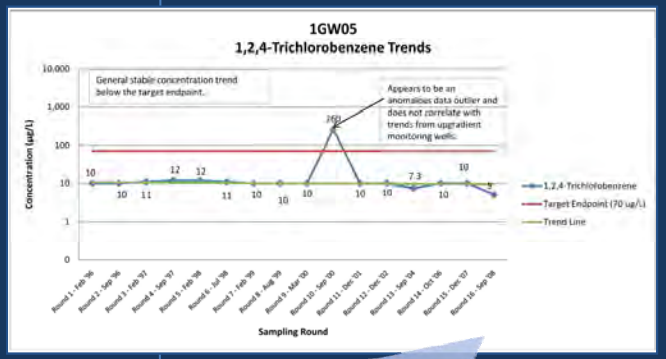
collected during Round 16 are provided in **Appendix A**.

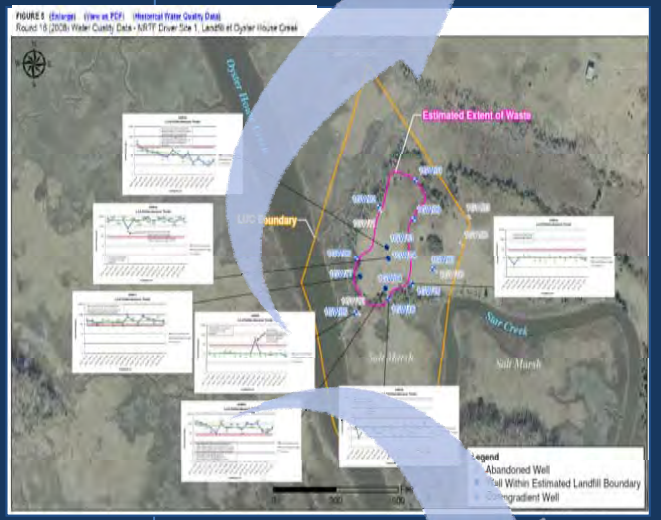
Chlorobenzene Compounds

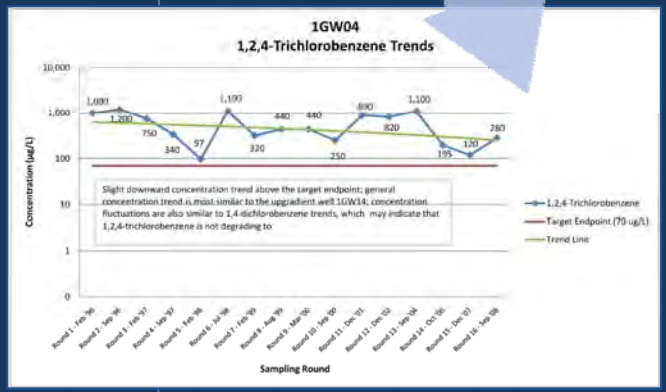
1,2,4-Trichlorobenzene was detected at six locations at Site 1 during Round 16 (1GW04, 1GW09, 1GW13, 1GW14, 1GW16, and 1GW17). The highest concentration (6,100 µg/L) was detected in the sample from 1GW14, in the central portion of the landfill. Concentrations exceeded the cleanup level of 70 µg/L at three locations within the landfill boundary only (1GW13, 1GW14, and 1GW17). Di-chlorobenzenes were also detected at these three locations. The concentration of 1,4-dichloro-benzene exceeded its cleanup level of 75 µg/L in the sample from 1GW14 (270 µg/L). There were no other dichlorobenzene exceedances of cleanup levels.

Concentrations of 1,2,4-trichlorobenzene have declined substantially in samples from 1GW14 over time, while concentrations in other surrounding wells (mostly downgradient wells) and concentrations of dichlorobenzenes have remained about the same. This may be a result of generation of dichloro-benzenes during 1,2,4-trichlorobenzene degradation and downward migration. Trend graphs for the seven wells with 1,2,4-trichlorobenzene detections and for the six wells with 1,4-dichlorobenzene detections are included as **Figures 7 and 8**, respectively. On the basis of the data, it appears that impacts from chlorobenzene are limited to the shallow groundwater within the landfill and migration is limited. **Figures 9 and 10** show plume maps for 1,2,4-trichlorobenzene and total dichlorobenzenes, respectively.

Additional Information







Data Evaluation: Monitored Natural Attenuation

Document Content

For remedies that include enhanced degradation and/or Monitored Natural Attenuation, depict the following to demonstrate continued effectiveness, where applicable:

- Clear and meaningful trends of concentrations
- Estimated rates of natural attenuation and associated uncertainties
- Figures of groundwater concentrations over time
- Tables of microbial population and functional gene data
- Tables of geochemical data

Natural attenuation evaluations can be helpful for sites with various types of contaminants, including metals and radionuclides. Refer to state-specific and guidance and the United States Environmental Protection Agency natural attenuation guidance documents.

For More Information:

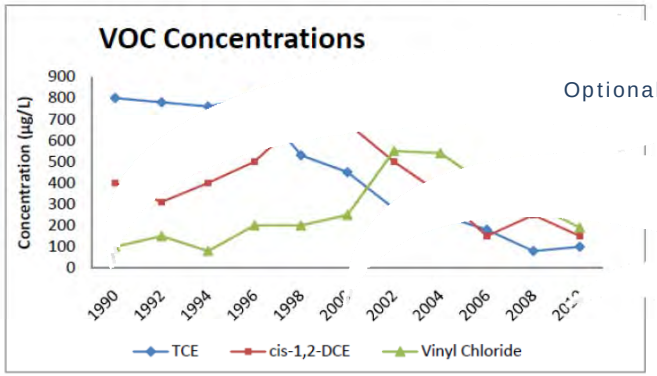
http://www.epa.gov/superfund/health/conmedia/gwdocs/monit.htm

Document View

5.3.3 Data Evaluation

5.3.3.1 Monitored Natural Attenuation

Chlorinated VOCs may attenuate in groundwater via several natural processes including reductive dechlorination. Reductive dechlorination of chlorinated VOCs involves the reduction in parent compound concentration, the subsequent accumulation of daughter products, and an increase in residual chloride ions. At Site 36, the parent compound is TCE. As TCE concentrations are decreasing, the concentrations of daughter products are increasing over time, indicating that reductive dechlorination is occurring (Figure 6-4).



Natural attenuation indicator parameters (NAIPs) can also be used to evaluate whether aquifer conditions are favorable for reductive dechlorination. Table 6-7 summarizes the NAIP results obtained during the May 2010 annual LTM at Site 36. All NAIP results can be found on Table A-3 of Appendix A and Table D-2 of Appendix D.

TABLE 6-7
Site 36 Summary of Natural Attenuation Indicator Parameters

Natural Attenuation Indicator Parameter	Range of Results (May 2010)	Condition Needed for Reductive Dechlorination	Favorable/ Unfavorable
Surficial Aquifer: 4 to 24 ft bgs			
ORP (mV)	-145 - 47	Less than +50 mV (favorable) Less than -100 mV (ideal)	Favorable
DO (mg/L)	0.2 - 6.3	Less than 1.0 mg/L	Favorable
Nitrate (mg/L)	Not Detected - 1.0	Less than 1.0 mg/L	Favorable
Ferrous Iron (Fe^{2+}) (mg/L)	0.3 - 4.8	Measurable Levels	Favorable
Sulfate (mg/L)	36.1 - 262	Less than 20 mg/L	Unfavorable
Alkalinity (mg/L)	184 - 344	[1]Above Background	Favorable
Chloride (mg/L)	7.38 - 18.5	[1]Above Background	Favorable
Methane (µg/L)	51.8 - 64.5	[1]Above Background	Unfavorable
Total Organic Carbon (mg/L)	1.38 - 7.19	[1]Below Background	Unfavorable

Additional Information

Optional Link

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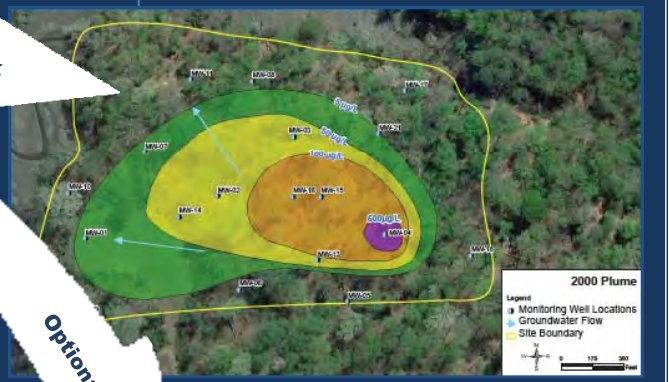
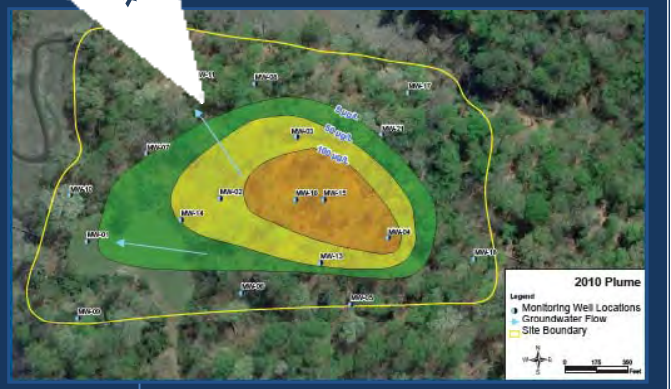




Remedy Performance and Protectiveness

Document Content

This section should evaluate whether the implementation and performance of the remedy is protective of human health and the environment and should reference data evaluation results to support remedy performance and protectiveness conclusions. Also identify if future actions are needed for optimization or to ensure continued protectiveness. To support this section, revisit the Five-Year Review and include the site-specific issues and recommendations, track the current status of addressing any issues, and plan for the next Five-Year Review. A table can be used to summarize the Five-Year Review issues, recommendations, follow-up actions, and current status. To assess the continued protectiveness of the remedy, consider site-specific answers to the following questions:

- Is the remedy functioning as intended by the decision documents?
- Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?
- Has any other information come to light that could call into question the protectiveness of the remedy?

Five-Year Reviews may not be applicable to all sites (e.g., state cleanups); however, protectiveness evaluations may be applicable to evaluating effectiveness of other remedies.

Document View

4.3 FY 2010 LTM Data Evaluation

COCs detected in groundwater samples at concentrations exceeding Site 3 RGs are summarized in **Table 4-5**, shown on **Figure 4-4**, and provided in **Table A-1** of **Appendix A**. **Figure 4-5** identifies the approximate extent of impacted groundwater above current site-specific RGs and **Figure 4-6** illustrates the temporal changes of COC concentrations.

Evaluation of the FY 2010 LTM data collected at Site 3 indicates the following:

- One VOC, vinyl chloride, was detected in a groundwater sample collected from monitoring well IR03-MW02IW at a concentration exceeding the NCGWQS and RG (0.242 J µg/L) during the March sampling event, but was not detected above method detection limits in either the May or August sampling events. Vinyl chloride continues to be detected sporadically with no apparent trend. **Figure 4-6** shows historical vinyl chloride concentrations in groundwater samples collected from IR03-MW02IW. Although benzene was detected in groundwater collected form IR03-MW02IW in all three sampling events in 2010, no detections exceeded the NCGWQS or RG (**Table A-1** of **Appendix A**).
- As summarized above in **Table 4-5**, six SVOCs, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, and naphthalene, were detected in multiple groundwater samples at concentrations exceeding NCGWQS and/or RGs. Overall, the concentrations of PAHs detected in groundwater samples collected at Site 3 have declined since the beginning of LTM (**Figure 4-6**). This is likely due to the source removal and natural attenuation processes.
- No detections of either VOC [illegible] surficial aquifer monitoring well IR03-MW11 during FY 2010 LTM activities (**Tab[illegible]**).

4.4 Five-Year Review

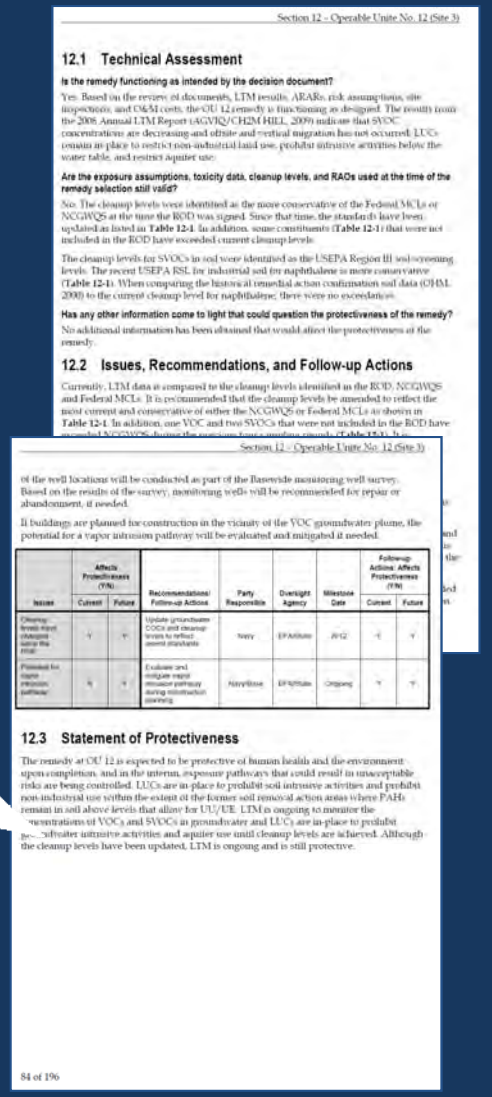
A Five-Year Review was signed for Site 3 in 2010 and concluded that LTM [illegible] protective. LUCs are in place to prohibit soil intrusive activities and prohibit non-ind[illegible] the extent of the former soil removal action areas. LTM is ongoing to monitor the conce[illegible] VOCs and SVOCs in groundwater and LUCs are in place to prohibit groundwater intrusive ac[illegible] and aquifer use until cleanup levels are achieved. Two recommendations/follow-up [illegible] (**Table 4-6**) were identified (CH2M HILL, 2010).

TABLE 4-6
Issues and Recommendation/Follow-Up Actions Identified at Site 3

Issues	Recommendations / Follow-up Actions	Current Status
NCGWQS have changed since the ROD	Update remedial goals to reflect current NCGWQS recent standards.	Remedial Goals have been updated to reflect current NCGWQS.
Potential for vapor intrusion pathway	Evaluate and mitigate vapor intrusion pathway during construction planning.	There is no risk from vapor intrusion based on current land use. Basewide vapor intrusion evaluation is ongoing and will be re-evaluated as part of the next Five-Year Review. Groundwater VOC plumes are provided to the Base GIS annually for construction planning.

Optional Link

Additional Information



Section 12 - Operable Unite No. 12 (Site 3)

12.1 Technical Assessment

Is the remedy functioning as intended by the decision document?

Yes. Based on the review of documents, LTM results, ARARs, risk assumptions, site inspections, and O&M costs, the OU 12 remedy is functioning as designed. The results from the 2008 Annual LTM Report (AGVIQ/CH2M HILL, 2009) indicate that SVOC concentrations are decreasing and offsite and vertical migration has not occurred. LUCs remain in place to restrict non-industrial land use, prohibit intrusive activities below the water table, and restrict aquifer use.

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

No. The cleanup levels were identified as the more conservative of the Federal MCLs or NCGWQS at the time the ROD was signed. Since that time, the standards have been updated as listed in **Table 12-1**. In addition, some constituents (**Table 12-1**) that were not included in the ROD have exceeded current cleanup levels.

The cleanup levels for SVOCs in soil were identified as the USEPA Region III soil screening levels. The recent USEPA RSL for industrial soil for naphthalene is more conservative (**Table 12-1**). When comparing the historical remedial action confirmation soil data (CH2M, 2008) to the current cleanup level for naphthalene, there were no exceedances.

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

No additional information has been obtained that would affect the protectiveness of the remedy.

12.2 Issues, Recommendations, and Follow-up Actions

Currently, LTM data is compared to the cleanup levels identified in the ROD, NCGWQS and Federal MCLs. It is recommended that the cleanup levels be amended to reflect the most current and conservative of either the NCGWQS or Federal MCLs as shown in **Table 12-1**. In addition, one VOC and two SVOCs that were not included in the ROD have exceeded NCGWQS during the previous four sampling rounds (**Table [illegible]**). It

Section 12 - Operable Unite No. 12 (Site 3)

of the well locations will be conducted as part of the Basewide monitoring well survey. Based on the results of the survey, monitoring wells will be recommended for repair or abandonment, if needed.

If buildings are planned for construction in the vicinity of the VOC groundwater plume, the potential for a vapor intrusion pathway will be evaluated and mitigated if needed.

Issues	Affects Protectiveness (Y/N) Current	Affects Protectiveness (Y/N) Future	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Protectiveness (Y/N) Current	Follow-up Actions: Affects Protectiveness (Y/N) Future
Cleanup levels have changed since the ROD	Y	Y	Update groundwater COCs and cleanup levels to reflect current standards	Navy	EPA/State	2012	Y	Y
Potential for vapor intrusion pathway	N	Y	Evaluate and mitigate vapor intrusion pathway during construction planning	Navy/Base	EPA/State	Ongoing	N	Y

12.3 Statement of Protectiveness

The remedy at OU 12 is expected to be protective of human health and the environment upon completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. LUCs are in place to prohibit soil intrusive activities and prohibit non-industrial use within the extent of the former soil removal action areas where PAHs remain in soil above levels that allow for UU/UE. LTM is ongoing to monitor the [illegible]centrations of VOCs and SVOCs in groundwater and LUCs are in place to prohibit [illegible]ndwater intrusive activities and aquifer use until cleanup levels are achieved. Although the cleanup levels have been updated, LTM is ongoing and is still protective.

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Cost

Document Content

The cost section should provide a summary of the capital cost for construction of the remedy, current costs, and project-to-date costs for management and monitoring. Table(s) can be used to present detailed cost information for labor, equipment/ materials, and travel for key project tasks. This will help Remedial Project Managers (RPMs) project future costs and identify areas for potential cost avoidance.

If historical cost data is not available to track cost, the RPM should arrange for the collection and tracking of current and future cost data from this point forward. A comparison of the total remedy cost in the Record of Decision (ROD) versus projected actual costs should also be provided. Include an explanation of any reductions or increases in remedy costs. If the cost change is significant, refer to the Conclusions and Recommendations section for information on how to document post-ROD changes.

Document View

4. REMEDY IMPLEMENTATION AND EVALUATION

4.5 Cost

Remedy implementation began in FY2003. The capital cost for construction was approximately $450,000. Following remedy construction, four rounds of groundwater monitoring for VOCs and natural attenuation indicator parameters have been conducted. **Table 4-5** outlines the FY2009 and project to date (PTD) costs for groundwater monitoring. **Table 4-6** outlines the FY2009 and PTD costs for site operations and maintenance (O&M). O&M costs include one additional ERD injection conducted during FY2008 management and monitoring activities.

Table 4-5 Monitoring Costs

Task	Labor		Equipment/Material		Travel	
	FY2009	PTD	FY2009	PTD	FY2009	PTD
Project Planning	$ 5,000	$ 50,000	$ -	$ -	$ -	$ -
Sampling	$ 9,000	$ 39,000	$ 650	$ 2,700	$ 400	$ 1,700
Waste Disposal	$ 700	$ 3,000	$ 150	$ 700	$ 300	$ 1,300
Analysis	$ 9,000	$ 35,000	$ -	$ -	$ -	$ -
Reporting	$ 22,000	$ 44,000	$ 200	$ 400	$ -	$ -
Optimization	$ 12,000	$ 12,000	$ -	$ -	$ -	$ -
Subtotal	$ 57,700	$ 183,000	$ 1,000	$ 3,800	$ 700	$ 3,000
FY2009 Total						$ 59,400
PTD Total						$ 189,800

Table 4-6 Operations and Maintenance Costs

Task	Labor		Equipment/Material		Travel	
	FY2009	PTD	FY2009	PTD	FY2009	PTD
Project Planning	$ -	$ 4,000	$ -	$ -	$ -	$
Injection	$ -	$ 16,500	$ -	$ 11,500	$ -	
Inspections	$ 400	$ 1,600	$ 100	$ 200	$ 1	
Waste Disposal	$ -	$ 700	$ -	$ 150		$ 300
Subtotal	$ 400	$ 22,800	$ 100	$ 11,850		$ 1,100
FY2009 Total						$ 600
PTD Total						$ 35,750

Based upon management and monitoring costs to date, it is estimate that remedy implementation (capital cost and fifteen years of management and monitoring costs) will be $1,450,650. Total remedy cost includes an assumed three additional ERD injections. **Total remedy cost** outlined in the ROD was $1,900,000. Projected remedy cost is within the required -30%/+50% range.

4-4

Optional Link

Additional Information

TABLE 4
Remedial Alternatives Summary

Alternative	Components	Details	Cost
1-NO Action	None	Allow the COCs to breakdown naturally over time	No cost associated with this alternative Cost estimate timeframe: 0 yrs
2- ERD	• In-situ biological treatment to enhance natural biodegradation • LUCs • Performance monitoring and LTM	Electron donor source, which is generally the limiting factor, is provided to enhance naturally occurring reductive dechlorination process. Install two new monitoring wells. Implement LUCs to prevent exposure and control changes in site use. Regular monitoring performed to demonstrate that: • COC concentrations continue to decrease. • Potentially toxic transformation products are not created at levels that are a threat to human health. • Affected area is not expanding. • There are no changes in hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action. • Temporary conditions do not result in COC concentrations in indoor air at levels that are a threat to building occupants.	Capital Cost = $401,200 O&M Present Value = $2,590,000 Total Present Value Cost = $2,980,000 -30%/+50%: $2,090,000 / $4,480,000 Cost estimate timeframe: 30 yrs
3- ISCO and ERD	•ISCO treatment in source area to oxidize COCs. •In-situ biological treatment to enhance natural biodegradation. •LUCs • Performance monitoring and LTM	Injection of oxidizing agent to promote abiotic in-situ oxidation of COCs through reaction of oxidants with the COCs to produce innocuous substances such as carbon dioxide, water, and chloride. Electron donor source, which is generally the limiting factor, is provided to enhance naturally occurring reductive dechlorination process. Install two new monitoring wells. Implement LUCs to prevent exposure and control changes in site use. Regular monitoring performed to demonstrate that: • COC concentrations continue to decrease. • Potentially toxic transformation products are not created at levels that are a threat to human health. • Affected area is not expanding. • There are no changes in hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action. • Temporary conditions do not result in COC concentrations in indoor air at levels that are a threat to building occupants.	Capital Cost = $582,400 O&M Present Value = $2,840,000 Total Present Value Cost = $3,420,000 -30%/+50%: $2,390,000 / $5,130,000 Cost estimate timeframe: 30 yrs
4- AS/SVE	•In-situ biological treatment to induce volatilization of COCs and/or aerobic biological degradation. •In-situ and ex-situ remedial technology used to withdraw and treat contaminant vapors from soil. •LUCs • Performance monitoring and LTM	Installation of AS/SVE system in the source and downgradient edge of plume to inject air into the groundwater to induce volatilization of COCs in groundwater and enhance biodegradation. Pilot study in the source area followed by full-scale system installation in the source area and downgradient edges of the plume. Installation of two new monitoring wells. Implement LUCs to prevent exposure and control changes in site use. Regular monitoring performed to demonstrate that: • COC concentrations continue to decrease. • Potentially toxic transformation products are not created at levels that are a threat to human health. • Affected area is not expanding. • There are no changes in hydrogeologic conditions that might reduce the effectiveness of the Remedial Action. • Temporary conditions do not result in COC concentrations in indoor air at levels that are a threat to building occupants. • O&M of the AS/SVE system.	Capital Cost = $665,900 O&M Present Value = $2,970,000 Total Present Value Cost = $3,640,000 -30%/+50%: $2,550,000 / $5,460,000 Cost estimate timeframe: 30 yrs

Optimization

Document Content

This section should describe the optimization strategies used to develop the most efficient and cost-effective sampling approach. See Navy guidance for optimizing remedial actions. An optimization review should be completed at all sites to:

- Assess relative importance of individual monitoring points
- Determine optimum duration and frequency
- Evaluate field procedures for efficiency
- Streamline data management and reporting
- Ensure consistency with the Navy's sustainability goals

Optimization efforts can be accomplished through simple data evaluation or use of optimization software for sites with a large number of data points and/or high monitoring frequency. For more information see optimization attachment.

Consider temporal optimizations for reducing sampling frequency. For spatial optimization, providing the rationale for each sample point (e.g., upgradient, downgradient, within plume) shows the significance of each point and relationship to the monitoring program and land use controls. Providing rationale for changes to the number of points (e.g., redundant or extraneous sample points) in a sampling network or the frequency of sampling is an easy exercise.

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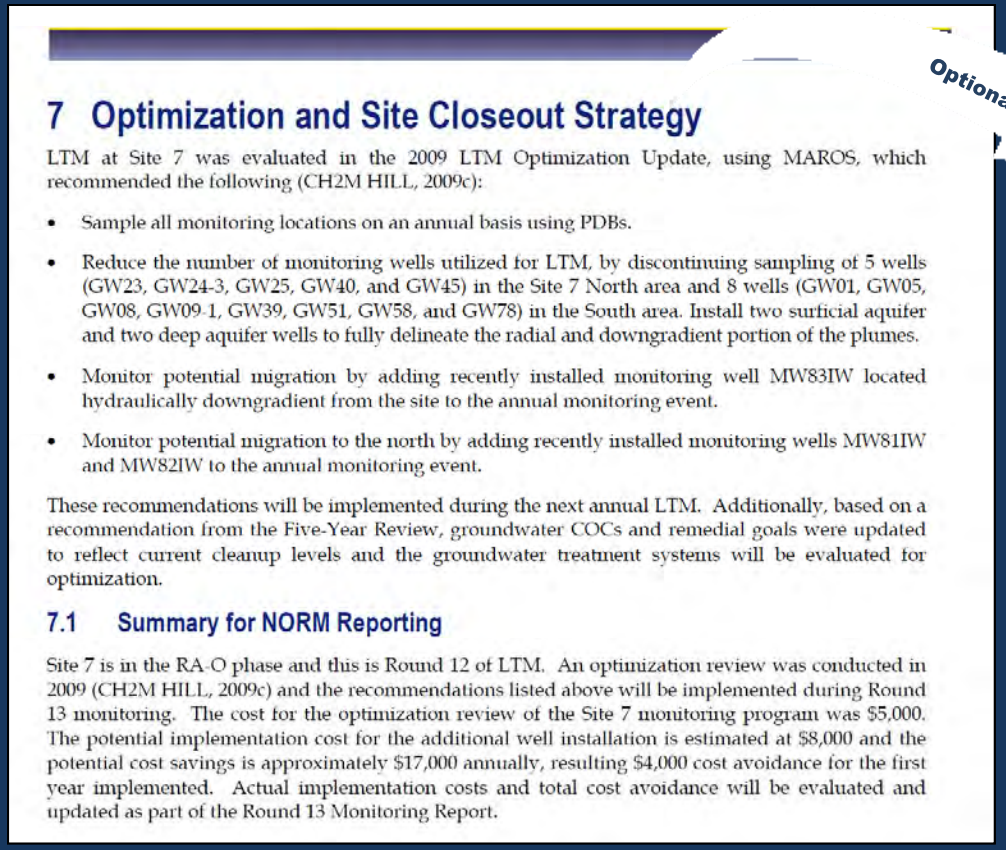


7 Optimization and Site Closeout Strategy

LTM at Site 7 was evaluated in the 2009 LTM Optimization Update, using MAROS, which recommended the following (CH2M HILL, 2009c):

- Sample all monitoring locations on an annual basis using PDBs.
- Reduce the number of monitoring wells utilized for LTM, by discontinuing sampling of 5 wells (GW23, GW24-3, GW25, GW40, and GW45) in the Site 7 North area and 8 wells (GW01, GW05, GW08, GW09-1, GW39, GW51, GW58, and GW78) in the South area. Install two surficial aquifer and two deep aquifer wells to fully delineate the radial and downgradient portion of the plumes.
- Monitor potential migration by adding recently installed monitoring well MW83IW located hydraulically downgradient from the site to the annual monitoring event.
- Monitor potential migration to the north by adding recently installed monitoring wells MW81IW and MW82IW to the annual monitoring event.

These recommendations will be implemented during the next annual LTM. Additionally, based on a recommendation from the Five-Year Review, groundwater COCs and remedial goals were updated to reflect current cleanup levels and the groundwater treatment systems will be evaluated for optimization.

7.1 Summary for NORM Reporting

Site 7 is in the RA-O phase and this is Round 12 of LTM. An optimization review was conducted in 2009 (CH2M HILL, 2009c) and the recommendations listed above will be implemented during Round 13 monitoring. The cost for the optimization review of the Site 7 monitoring program was $5,000. The potential implementation cost for the additional well installation is estimated at $8,000 and the potential cost savings is approximately $17,000 annually, resulting $4,000 cost avoidance for the first year implemented. Actual implementation costs and total cost avoidance will be evaluated and updated as part of the Round 13 Monitoring Report.

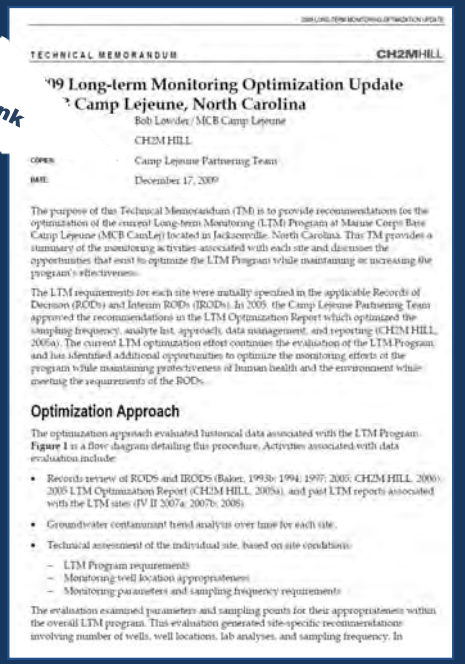
Example optimization tools further discussed in the attachment include:

- Geostatistical Temporal-Spatial Algorithm (GTS)
- Monitoring and Remediation Optimization Software (MAROS)
- Natural Attenuation Software (NAS)
- Navy Vapor Intrusion Evaluation Tool
- Remediation Evaluation Model for chlorinated solvents (REMChlor)
- Ricker Plume Stability Method
- Spatial Analysis and Decision Assistance (SADA)
- Sitewise™
- Summit

Each software tool has its pros and cons. See the optimization attachment for additional direction and applicability of each tool. Contact your Optimization Team Representative for more information on the use of optimization tools and approaches.

Additional Information

Optional Link



TECHNICAL MEMORANDUM CH2MHILL

'09 Long-term Monitoring Optimization Update
Camp Lejeune, North Carolina

Bob Lowder/MCB Camp Lejeune
CH2M HILL
Camp Lejeune Partnering Team
December 17, 2009

The purpose of this Technical Memorandum (TM) is to provide recommendations for the optimization of the current Long-term Monitoring (LTM) Program at Marine Corps Base Camp Lejeune (MCB CamLej) located in Jacksonville, North Carolina. This TM provides a summary of the monitoring activities associated with each site and discusses the opportunities that exist to optimize the LTM Program while maintaining or increasing the program's effectiveness.

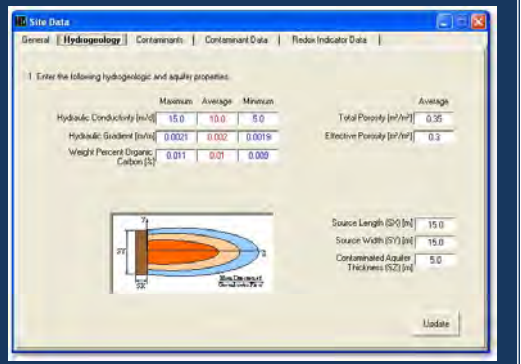
The LTM requirements for each site were initially specified in the applicable Records of Decision (RODs) and Interim RODs (IRODs). In 2005, the Camp Lejeune Partnering Team approved the recommendations in the LTM Optimization Report which optimized the sampling frequency, analyte list, approach, data management, and reporting (CH2M HILL, 2005a). The current LTM optimization effort continues the evaluation of the LTM Program and has identified additional opportunities to optimize the monitoring efforts of the program while maintaining protectiveness of human health and the environment while meeting the requirements of the RODs.

Optimization Approach

The optimization approach evaluated historical data associated with the LTM Program. Figure 1 is a flow diagram detailing this procedure. Activities associated with data evaluation include:

- Records review of RODS and IRODS (Baker, 1993b; 1994; 1997; 2005; CH2M HILL, 2006); 2005 LTM Optimization Report (CH2M HILL, 2005a), and past LTM reports associated with the LTM sites (JV II 2007a; 2007b; 2008)
- Groundwater contaminant trend analysis over time for each site.
- Technical assessment of the individual site, based on site conditions:
  - LTM Program requirements
  - Monitoring well location appropriateness
  - Monitoring parameters and sampling frequency requirements

The evaluation examined parameters and sampling points for their appropriateness within the overall LTM program. This evaluation generated site-specific recommendations involving number of wells, well locations, lab analyses, and sampling frequency. In



Optimization contd.

Document Content

The optimization section of the report should include the information needed to populate and update the Navy "Normalization of Data" database (NORM) module. This includes the cost of the optimization review and the potential and actual cost for implementation and cost avoidance.

Tracking the annual and long term cost for the management and monitoring program versus the success of the remedial action (e.g., volatile organic compounds removed) can help to identify areas for cost avoidance. Tables or graphs can be used to track overall monitoring and management costs and the potential cost avoidance in follow-on years if optimization efforts are implemented.

Document View

7 Optimization

LTM at Site 7 was evaluated in the 2009 LTM Optimization Update, using MAROS, which recommended the following (CH2M HILL, 2009c):

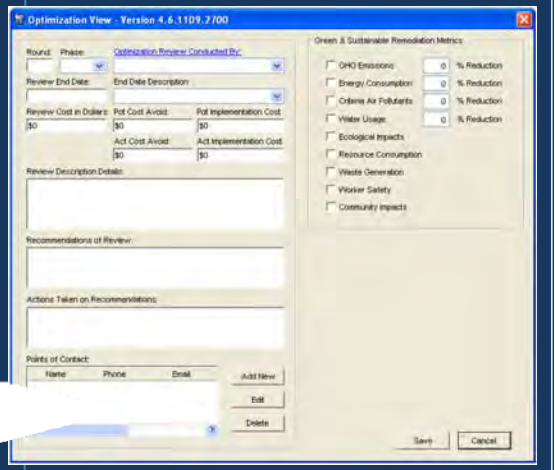
- Sample all monitoring locations on an annual basis using PDBs.
- Reduce the number of monitoring wells utilized for LTM, by discontinuing sampling of 5 wells (GW23, GW24-3, GW25, GW40, and GW45) in the North area and 8 wells (GW01, GW05, IR78-GW08, GW09-1, GW39, GW51, GW58, and GW78) in the South area. Install two surficial aquifer and two deep aquifer wells to fully delineate the radial and downgradient portion of the plumes.
- Monitor potential migration by adding recently installed monitoring well MW83IW located hydraulically downgradient from the site to the annual monitoring event.
- Monitor potential migration to the north by adding recent[illegible] and MW82IW to the annual monitoring event.

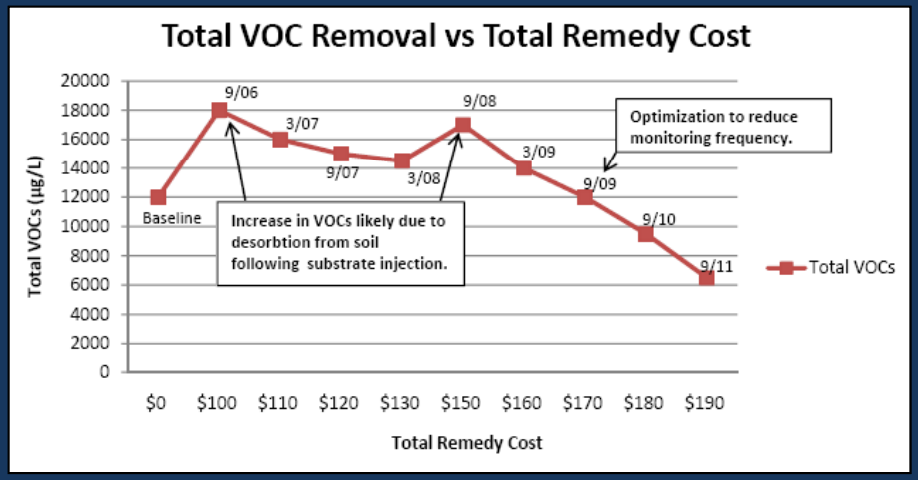
These recommendations will be implemente[illegible] annual LTM. Additionally, ba[illegible] on a recommendation from the Five-Year Revie[illegible] groundwater COCs and remedial goals were updated to reflect current cleanup levels and th[illegible] groundwater treatment systems will be evaluated for optimization.

7.1 Summary for NORM Reporting

Site 7 is in the RA-O phase and this is Round 12 of LTM. An optimization review was conducted in 2009 (CH2M HILL, 2009c) and the recommendations listed above will be implemented during Round 13 monitoring. The cost for the optimization review of the Site 7 monitoring program was $5,000. The potential implementation cost for the additional well installation is estimated at $8,000 and the potential cost savings is approximately $17,000 annually; resulting in $4,000 cost avoidance for the first year implemented. Actual implementation costs and total cost avoidance will be evaluated and updated as part of the Round 13 Monitoring Report.

NORM Module





Site Closeout Strategy

Document Content

The purpose of this section is to clearly state the decision points to reach site closeout. Include a discussion that outlines the current progress towards reaching site closeout (i.e., exit strategy) and the path forward as reflected in the data quality objectives section. A decision tree format can be used to effectively communicate the decision points and potential flow paths. The key elements of a decision tree include:

- Action(s) taken
- Metric(s) for action success
- Path(s) towards site closeout
- Metric(s) for reaching site closeout

Any key decisions regarding site closeout should be documented (e.g., individual constituents of concern have met respective cleanup goals, monitoring wells can be removed from sampling network, frequency of sampling can be reduced, etc.). Provide reference to guidance and policy documents if applicable in the decision-making process.

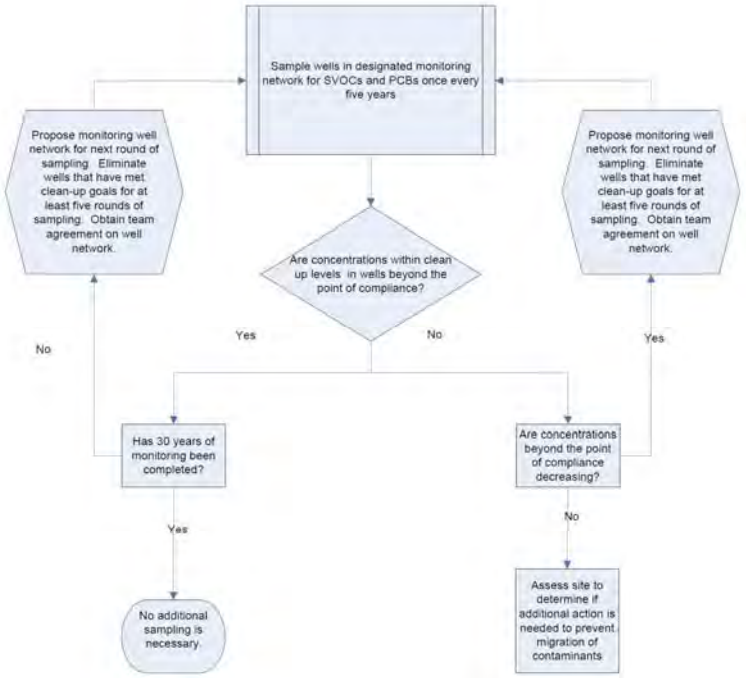
Document View

Reference Documents

5. CLOSEOUT STRATEGY

5. Closeout Strategy

FIGURE 14
Decision Tree – Groundwater - NRTF Driver Site 1, Landfill at Oyster House Creek



6. Conclusions and Recommendations

This section presents the conclusions and recommendations for the NRTF Driver LTM Program, following a review of the Year 12/Round 16 analytical results and comparison with past LTM rounds.

6.1 Conclusions

- The LUCs to prohibit intrusive activities and groundwater use are in place, protective, and will be maintained.

Additional Information

Role of Background in the CERCLA Cleanup Program

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Office of Emergency and Remedial Response
April 26, 2002
OSWER 9285.6-07P

Considerations for Developing Long-Term Monitoring (LTM) Plans for Unpermitted Navy Landfills in Virginia

Virginia – Navy Tier II Issue Paper

I. OBJECTIVE

This memorandum presents considerations for developing Long-Term Monitoring (LTM) Plans for Virginia Navy landfills that last received waste prior to 1993 that are managed under the Navy Environmental Restoration (ER) Program in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Landfills that are managed under a Resource Conservation and Recovery Act (RCRA) permit are subject to the RCRA permitting requirements. This document represents guidelines developed by the Navy-Virginia Tier II Partnering Team and is not intended to supercede, limit, or change any guidance, policy or regulations developed by EPA, the Navy, or the Commonwealth of Virginia. These guidelines are not a regulation and do not impose legal obligations.

II. BACKGROUND

Many Navy landfills ceased operation decades prior to Federal or State Solid Waste Management Regulations. These landfills are often managed in compliance with CERCLA under the Navy ER Program. To ensure protection of human health and the environment, the typical landfill remedy includes a soil cover; land use controls (LUCs); landfill inspections; and groundwater monitoring. In many cases, groundwater monitoring programs have been implemented to mirror the requirements for permitted landfills in accordance with Virginia Solid Waste Management Regulations. In the absence of specific guidance, the objectives and approaches for LTM (media, parameters, and frequency) vary widely and there is generally no defined exit strategy. The Navy has implemented remedial actions at unpermitted landfill sites. Some of these Navy landfill sites ceased receiving waste prior to 1988.

The Virginia Solid Waste Management Regulations specify long term monitoring at landfills based on the date of waste disposal activities. These requirements need to be reviewed in concert with the Navy's responsibilities under CERCLA for waste remaining in place.

- The early state regulations were issued in 1971 and 1988.
- Municipal Solid Waste landfills (MSW) that ceased to accept waste between 12/21/88 and 10/09/93 are required to monitor groundwater quality and are subject to post closure care (PCC) requirements for 10 years under a RCRA permit.
- MSW landfills that ceased to accept waste on or after 10/9/93 are required to conduct PCC for 30 years under a RCRA permit.

Conclusions and Recommendations

Document Content

This section should present the key findings of the management and monitoring period, progress toward site closure, any issues identified, and recommendations. This section should reflect the results of site optimization efforts and any corrective actions required. A table can be used to summarize the current site status and conclusions, recommendations from previous reports, current recommendations, and milestones for completion.

Document any changes to the sampling plan (including detailed sampling network and frequency, sampling and analytical methods, and project action limits) to facilitate work planning for completion of future monitoring events.

If the conclusions and recommendations result in changes to the selected remedy, consider documentation required for post-Record of Decision (ROD) changes. There are three types of post-ROD documentation for changes based on scope, performance, and cost. Refer to United States Environmental Protection Agency's (USEPA's) *A Guide to Preparing Superfund Proposed Plans, Records of Decisions, and Other Remedy Selection Decision Documents* (EPA, July 1999) for more information.

Document View

10 Conclusions and Recommendations

This section presents the conclusions and recommendations for the MCB Cam… Program, following a review of FY 2010 analytical results and comparison with past LTM rounds.

Site 3

Conclusions

LTM and LUCs are still protective.

- LUCs are in place to prohibit soil intrusive activities and prohibit non-industrial use within extent of the former soil removal action areas and LUCs are in place to prohibit groundwat… intrusive activities and aquifer use until cleanup levels are achieved.
- Vinyl chloride is only occasionally detected in groundwater samples collected from monitoring well IR03-MW02IW, at concentrations exceeding NCGWQS, but at low concentrations: 0.26 J µg/L in August 2006, 0.21 J µg/L in August 2008, and 0.242 J µg/L in March 2010.
- Although benzene was detected in groundwater collected from IR03-MW02IW in all three sampling events in FY 2010, no detections exceeded NCGWQS.
- PAH exceedances of NCGWQS and RGs (acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, and naphthalene) continue to be noted in groundwater collected from two surficial aquifer (IR03-MW02 and IR03-MW06) and one upper Castle Hayne aquifer (IR03-MW02IW) monitoring well in the LTM program, however, concentrations of PAHs detected in groundwater samples collected at Site 3 continue to show an overall decline since the beginning of LTM.
- No detections of either VOCs or PAHs were noted in surficial aquifer monitoring IR03-MW11 during FY 2010 LTM activities.

Recommendations

LTM of COCs is recommended at Site 3 until the RAOs defined in the site-specific ROD are achieved for four consecutive events.

Table 1
Summary of LTM Regulatory Framework, Monitoring Status, and Recommendations
2009 Long-Term Monitoring Optimization Tech Memo
MCB Camp Lejeune
North Carolina

Site	Regulatory Status	Current Monitoring Status	2009 LTMO Recommendations
OU 1, Site 78	ROD 1994, LUCs updated 2002 Groundwater extraction and treatment, LUCs, and LTM	39 monitoring wells, 9 recovery wells. VOCs; 5 wells sampled quarterly, remaining wells sampled annually.	31 monitoring wells (27 existing and 4 proposed monitoring wells) and 9 recovery wells: Sample all wells annually for VOCs utilizing PDB sampling technique. The proposed monitoring locations are as follows: One shallow/intermediate nested pair located near IR78-GW43. IR78-GW43 can be used as shallow well if ilocated. A second shallow/intermediate nested pair recommended for installation approximately 200 ft southwest of IR78-GW40 and IR78-GW47. Monitoring well IR78-RW09R was added to program in August 2008 since recovery well IR78-RW09 was damaged and could no longer be sampled.
OU 2, Site 6	ROD 1993, LUCs updated 2002 LUCs, and LTM	Monitoring 8 wells for VOCs (5 shallow monitoring wells and 3 deep monitoring wells) annually.	No recommended changes to LTM program.
OU 12, Site 3	ROD amended 2000 Soil removal and LTM	4 monitoring wells. VOCs, SVOCs; annual sampling.	No recommended changes to LTM program.

Additional Information

Three types of post-ROD changes and required documentation include:

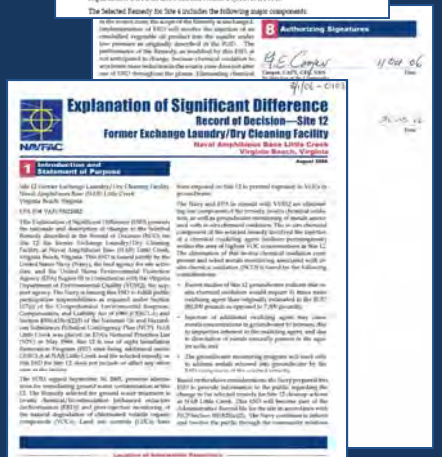
1. Minor or non-significant changes - Memo to File
   - Revised monitoring frequency/ locations
2. Significant changes - Explanation of Significant Difference
   - Change in ARAR or LUC
   - Implement contingency remedy
3. Fundamental changes - ROD Amendment
   Change in treatment method

Reference Post-ROD documentation when applicable


FINAL TECHNICAL MEMORANDUM CH2MHILL

Minor Modifications to the Selected Remedy Presented in the Record of Decision for Site 4 - Landfill D, St. Juliens Creek Annex, Chesapeake, Virginia

Background and Description of Selected Remedy


Explanation of Significant Difference
Record of Decision—Site 12
Former Exchange Laundry/Dry Cleaning Facility

1 Introduction and Statement of Purpose

Navy Environmental Restoration Program Management and Monitoring Approach 24

Acronyms and Abbreviations

Document Content

This section includes a list of the acronyms and abbreviations used throughout the report.

Acronyms and Abbreviations

A2LA	American Association for Laboratory Accreditation
Act	Actual
AFCEE	Air Force Center for Engineering and the Environment
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
AS/SVE	air sparging/soil vapor extraction
BERA	baseline ecological risk assessment
bgs	below ground surface
BRAC	Base Closure and Realignment
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethylbenzene, and xylenes
C	Celsius
CAPT	Captain
CD	compact disc
CEC	cation-exchange capacity
CEO	chief executive officer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
COC	constituent of concern
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DO	dissolved oxygen
DoD	Department of Defense
DoN	Department of Navy
DNAPL	dense non-aqueous phase liquid
DQO	data quality objective
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
ER	Environmental Restoration
ERA	Ecological Risk Assessment
ERD	enhanced reductive dechlorination
ESD	Explanation of Significant Difference
FS	feasibility study
ft	feet, foot
FY	fiscal year
GHG	greenhouse gas
GIS	geographic information system
GTS	Geostatistical Temporal-Spatial Algorithm
GW	groundwater
HI	hazard index
HHRA	human health risk assessment
IAS	Initial Assessment Study
IC	institutional control
ICR	incremental cancer risk

Acronyms and Abbreviations contd.

Document Content

This section includes a list of the acronyms and abbreviations used throughout the report.

IR	Installation Restoration
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISCO	in situ chemical oxidation
IW	intermediate well
JEB	Joint Expeditionary Base
lbs	pounds
LCR	lifetime cancer risk
LTM	long-term monitoring
LTMO	long-term monitoring optimization
LUC	land use control
LUCIP	land use control implementation plan
MAROS	Monitoring and Remediation Optimization Software
MCB	Marine Corps Base
MCB CamLej	Marine Corps Base Camp Lejeune
MCL	maximum contaminant level
MEE	methane, ethane, ethene
mg/kg	milligrams/kilogram
mg/L	milligrams/liters
MID LANT	Mid-Atlantic
MIP	membrane interface probe
MMBTU	one million British Thermal Unit
MNA	monitored natural attenuation
MSW	municipal solid waste
mV	millivolt
MW	monitoring well
NA	not applicable
NAB	Naval Amphibious Base
NAIP	natural attenuation indicator parameter
NAPL	non-aqueous phase liquid
NAVFAC	Naval Facilities Engineering Command
Navy	United States Navy
NCGWQS	North Carolina Groundwater Quality Standards
NCP	National Contingency Plan
ND	non-detect
NELAC	National Environmental Laboratory Accreditation
NERP	Navy Environmental Restoration Program
NFA	no further action
NIRIS	Naval Installation Restoration Information Solution
NOAA	National Oceanic and Atmospheric Administration
NORM	Normalization of Data
Nox	nitrogen oxide
NPL	National Priorities List
NRTF	Naval Radio Transmitting Facility
NS	not sampled
NTCRA	non-time critical removal action
O&M	operations and maintenance
Opt.	Option
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit

Acronyms and Abbreviations contd.

Document Content

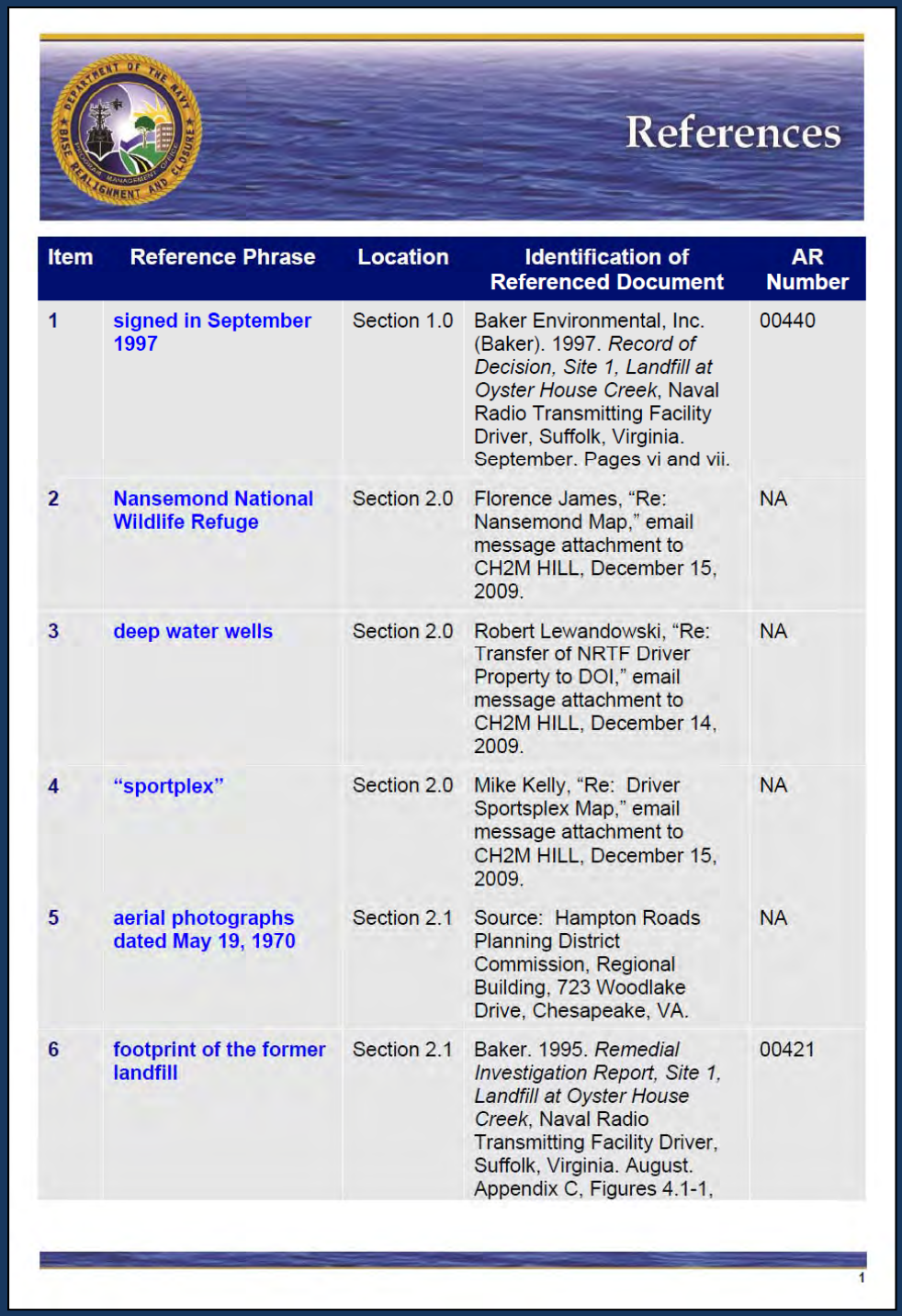
This section includes a list of the acronyms and abbreviations used throughout the report.

PAH	polycyclic aromatic hydrocarbon
PAL	project action limit
PCB	polychlorinated biphenyl
PCC	post-closure care
PCE	tetrachloroethylene
PDB	passive diffusion bag
PIL	performance indication levels
PM10	particulate matter with an effective diameter of 10 micrometers or less
Pot	potential
ppb	parts per billion
PRAP	Proposed Remedial Action Plan
PRG	preliminary remediation goal
PTD	project to-date
QSM	Quality Systems Manual
RA-O	Remedial Action-Operation
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RG	remedial goal
RI	Remedial Investigation
RITS	Remediation Innovative Technology Seminar
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	regional screening level
SADA	Spatial Analysis and Decision Assistance
SJCA	St. Juliens Creek Annex
SM	standard method
Sox	sulfur oxide
SVOC	semivolatile organic compound
SW	Solid Waste
TOC	total organic compound
TCE	trichloroethylene
TM	Technical Memorandum
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Survey
USN	United States Navy
UST	underground storage tank
UU/UE	unlimited use/unrestricted exposure
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
yr	year

References

Document Content

This section should contain a list of references to identify title/author/date, section number, page numbers, and Administrative Record numbers (where appropriate) for referenced / linked information. Include references to any guidance or policy documents (e.g., Record of Decision Toolkit, Uniform Federal Policy – Sampling Analysis Plan guidance, Applicable Business Management System, etc.) used to prepare the report. If using an interactive report format, the references section can provide the reader with immediate access to Administrative Record files and other references.



References

Item	Reference Phrase	Location	Identification of Referenced Document	AR Number
1	signed in September 1997	Section 1.0	Baker Environmental, Inc. (Baker). 1997. *Record of Decision, Site 1, Landfill at Oyster House Creek*, Naval Radio Transmitting Facility Driver, Suffolk, Virginia. September. Pages vi and vii.	00440
2	Nansemond National Wildlife Refuge	Section 2.0	Florence James, "Re: Nansemond Map," email message attachment to CH2M HILL, December 15, 2009.	NA
3	deep water wells	Section 2.0	Robert Lewandowski, "Re: Transfer of NRTF Driver Property to DOI," email message attachment to CH2M HILL, December 14, 2009.	NA
4	"sportplex"	Section 2.0	Mike Kelly, "Re: Driver Sportsplex Map," email message attachment to CH2M HILL, December 15, 2009.	NA
5	aerial photographs dated May 19, 1970	Section 2.1	Source: Hampton Roads Planning District Commission, Regional Building, 723 Woodlake Drive, Chesapeake, VA.	NA
6	footprint of the former landfill	Section 2.1	Baker. 1995. *Remedial Investigation Report, Site 1, Landfill at Oyster House Creek*, Naval Radio Transmitting Facility Driver, Suffolk, Virginia. August. Appendix C, Figures 4.1-1,	00421

1

Resources for Remedial Project Managers

Document Content

Resource documents are available to assist Remedial Project Managers in developing a monitoring and management approach.

Some Resources Available for Management and Monitoring Reports

- EPA ROD Guidance (EPA, 1999)
- Geostatistical Temporal/Spatial Optimization Algorithm (GTS): http://www.afcee.af.mil/resources/restoration/ltm/index.asp
- LTM-O Software Presentation (Navy RITS, Fall 2009)
- Monitoring and Remediation Optimization Software (MAROS): http://www.gsi-net.com/en/software/free-software/maros.html
- Navy Guidance for Optimizing Remedy Evaluation, Selection and Design (NAVFAC, 2010)
  - Guidance for Optimizing Remedial Action Operation (2001)
  - Guide to Optimal Groundwater Monitoring (2000)
- Navy's Guidance on Green and Sustainable Remediation (DoN, 2011)
- NAVFAC Sustainable Environmental Remediation Fact Sheet and website: http://www.ert2.org/t2gsrportal/
- Navy Environmental Restoration Program (NERP) Manual (DoN, 2006)
- Navy Vapor Intrusion Evaluation Tool
- Sitewise™
- Summit: http://www.sampleoptimizer.com/index_files/ESTCP.html