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JACKSON PARK COMPLEX
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FINAL SECOND FIVE-YEAR REVIEW FOR JACKSON PARK HOUSING COMPLEX & NAVAL HOSPITAL BREMERTON, BREMERTON, WA

01/04/2011

URS GROUP, INC.

NAVFAC
Naval Facilities Engineering Command

FINAL
4 January 2011

Second Five-Year Review

Jackson Park Housing Complex/ Naval Hospital Bremerton

Bremerton, Washington

Department of the Navy
Naval Facilities Engineering Command Northwest
1101 Tautog Circle
Silverdale, WA 98315

EXECUTIVE SUMMARY

As lead agency for environmental cleanup of Jackson Park Housing Complex/Naval Hospital Bremerton (JPHC/NHB), Bremerton, Washington, the U.S. Navy has completed the second 5-year review of the remedial actions at Operable Unit 1 (OU 1) conducted pursuant to Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300). The purpose of this 5-year review is to ensure that the remedial actions selected in the Record of Decision for OU 1 at JPHC/NHB remain protective of human health and the environment. A 5-year review is required for this site because the remedies allow contaminants to remain in place at concentrations that do not allow unlimited site use and unrestricted exposure. This second 5-year review was prepared in accordance with *Navy/Marine Corps Policy for Conducting Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Statutory Five-Year Reviews* (U.S. Navy 2004a) and the U.S. Environmental Protection Agency's *Comprehensive Five-Year Review Guidance* (USEPA 2001).

The remedies implemented for OU 1 at JPHC/NHB are protective both in the short and long terms, with the exception of the Benzene Release Area and human consumption of marine tissue.

The remedy in the Benzene Release Area is not protective, because benzene concentrations in seep water discharging to Ostrich Bay continue to exceed the remediation goal. Investigation, pilot testing, and removal actions are underway at the Benzene Release Area, with progress toward determining a revised remedy. The revised remedy is expected to be protective once selected and implemented.

The protectiveness of the remedy with regard to human consumption of marine tissue cannot be determined at this time, because analysis of marine tissue for ordnance compounds has not yet been performed using the recently developed analytical methodologies. Until such analysis can be completed, human exposure to marine tissue is being prevented through institutional controls that prohibit harvesting of shellfish from Ostrich Bay.

The remedies for OU 2 and OU 3 will be selected based on their protectiveness of human health and the environment. The remedies are therefore expected to be protective, once selected and implemented.

Future protectiveness requires adherence to the institutional controls and maintenance programs necessary to prevent unacceptable exposures, as well as implementation of the recommendations of this review.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name *(from WasteLAN)*: Jackson Park Housing Complex (USNAVY)

EPA ID *(from WasteLAN)*: WA3170090044

Region: 10	**State:** WA	**City/County:** Kitsap

SITE STATUS

NPL status: Final **X** Deleted Other (specify)_____

Remediation status (choose all that apply): Under Construction **X** Operating **X** Complete

Multiple OUs?* YES **X** NO	**Construction completion date:**

Has site been put into reuse? YES **X** NO

REVIEW STATUS

Lead agency: EPA State Tribe Other Federal Agency: Navy

Author name: Douglas Thelin

Author title: Remedial Project Manager	**Author affiliation:** Naval Facilities Engineering Command Northwest

Review period:** June 2004 to July 2009

Date(s) of site inspection: September 17, 2009

Type of review:

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

Review number: 2 (second)

Triggering action:

Actual RA Onsite Construction at OU#_____ ~~Actual RA Start~~
Construction Completion Previous Five-Year Review Report
Other (specify):_____

Triggering action date *(from WasteLAN)*: May 2006

Due date *(five years after triggering action date)*: May 2010

*["OU" refers to operable unit.]

**[Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form (Continued)

Issues:

- Land use controls related to discarded military munitions (DMM) are currently separate from other land use controls at the site and are not included in the Land Use Control Plan.
- The mercury remediation goal (RG) established post-Record of Decision (ROD) and used in monitoring documents is above the current practical quantitation limit (PQL), and the cyanide RG does not account for PQL limitations. Benzene and trichloroethene would have lower RGs if calculated today.
- The remedy for the Benzene Release Area is not functioning as intended by the ROD.
- Groundwater containing benzene at concentrations exceeding the RG is discharging to Ostrich Bay.
- Unresolved questions remain regarding whether ordnance compounds are present in marine tissue, whether risks to human health from these compounds are unacceptable, and whether arsenic concentrations in marine tissue present a risk to human health above background risks.
- Monitoring requirements for seeps and outfalls should be updated based on the monitoring results since the time of the ROD. The RGs used in the monitoring documents for copper and zinc do not match the ROD or post-ROD background study values.

Recommendations and Follow-up Actions:

- Update the Land Use Control Plan to include DMM-related land use controls, inspections, and reporting, and complete the land use control base instruction covering Jackson Park Housing Complex (JPHC) and Naval Hospital Bremerton (NHB).
- Review the basis of the RG (i.e., applicable or relevant and appropriate requirements, PQLs, and risk assessment assumptions) prior to any change in monitoring or institutional controls requirements.
- Complete additional investigation and pilot testing related to the Benzene Release Area, and optimize the remedy for this area.
- Develop a proposal for an interim action to address the discharge of groundwater containing benzene to Ostrich Bay.
- Perform an additional marine tissue sampling event utilizing the newly developed methods for ordnance compounds in marine tissue. Use the results of this event to verify the 2009 human health risk conclusions. Develop the sampling and analysis plan and quality assurance project plan for this sampling event in consultation with U.S. Environmental Protection Agency and the Suquamish Tribe.
- Revise the long-term monitoring plan to incorporate the specific changes listed in Section 6.4 of this review and the correct RGs for copper and zinc.

Protectiveness Statement(s):

The remedies implemented for Operable Unit 1 (OU 1) at JPHC/NHB are protective both in the short and long terms, with the exception of the Benzene Release Area and human consumption of marine tissue.

The remedy in the Benzene Release Area is not protective, because benzene concentrations in seep water discharging to Ostrich Bay continue to exceed the RG. Investigation, pilot testing, and removal actions are underway at the Benzene Release Area, with progress toward determining a revised remedy. The revised remedy is expected to be protective once selected and implemented.

Five-Year Review Summary Form (Continued)

Protectiveness Statement(s) (Continued):

The protectiveness of the remedy with regard to human consumption of marine tissue cannot be determined at this time, because analysis of marine tissue for ordnance compounds has not yet been performed using the recently developed analytical methodologies. Until such analysis can be completed, human exposure to marine tissue is being prevented through institutional controls that prohibit harvesting of shellfish from Ostrich Bay.

The remedies for OU 2 and OU 3 will be selected based on their protectiveness of human health and the environment. The remedies are therefore expected to be protective, once selected and implemented.

Other Comments: None

Signature sheet for the Jackson Park Housing Complex/Naval Hospital Bremerton second five-year review report.

CAPT, USN

M.J. OLSON
Captain, USN
Commanding Officer
Naval Base Kitsap

5 Jan '11
Date

Signature sheet for the Jackson Park Housing Complex/Naval Hospital Bremerton second five-year review report.

M. BROUKER
Captain, USN
Commanding Officer
Naval Hospital Bremerton

1/7/11
Date

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

APPENDICES

CONTENTS (Continued)

FIGURES

CONTENTS (Continued)

TABLES

ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BTEX	benzene, ethylbenzene, toluene, and total xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
DCE	dichloroethene
DMM	discarded military munitions
DNT	dinitrotoluene
DPE	dual-phase extraction
DRO	diesel-range organics
Ecology	Washington State Department of Ecology
EE/CA	engineering evaluation/cost analysis
EOD	explosive ordinance disposal
EPA	U.S. Environmental Protection Agency
FS	feasibility study
ft	foot
GRO	gasoline-range organics
HI	hazard index
IRIS	Integrated Risk Information System
JPHC	Jackson Park Housing Complex
LTM	long-term monitoring
M	marine
µg/kg	microgram per kilogram
µg/L	microgram per liter
mg/kg	milligram per kilogram
mg/kg-d	milligram per kilogram per day
MLLW	mean lower low water
MTCA	Model Toxics Control Act
MW	monitoring well
NAD	Naval Ammunition Depot
Naval Magazine	Naval Magazine Puget Sound
NAVFAC NW	Naval Facilities Engineering Command Northwest
Navy	U.S. Navy
NBK	Naval Base Kitsap
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

ABBREVIATIONS AND ACRONYMS (Continued)

NEX	Navy Exchange
NHB	Naval Hospital Bremerton
NOSSA	Naval Ordnance Safety and Support Activity
NPL	National Priorities List
O&M	operation and maintenance
ORC®	Oxygen Release Compound
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
ppm	parts per million
PQL	practical quantitation limit
PRS	Petroleum Reclaiming Services Group, Inc.
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDX	royal demolition explosive (cyclotrimethylene trinitramine)
RG	remediation goal
RI	remedial investigation
ROD	Record of Decision
RRO	residual-range organics
SMS	Sediment Management Standards
SVE	soil vapor extraction
SVOC	semivolatile organic compound
T	terrestrial
TCE	trichloroethene
TCRA	time-critical removal action
TPH	total petroleum hydrocarbons
TPH-G	total petroleum hydrocarbons—gasoline
URS	URS Group, Inc.
UST	underground storage tank
VOC	volatile organic compound

1.0 INTRODUCTION

This report presents the results of the second 5-year review performed for the Jackson Park Housing Complex/Naval Hospital Bremerton (JPHC/NHB) National Priorities List (NPL) site. The purpose of a 5-year review is to evaluate whether the implementation and performance of the remedies selected in the Record of Decision (ROD) for a site are or will be protective of human health and the environment. The methods, findings, and conclusions of 5-year reviews are documented in 5-year review reports, which identify any issues found during the review and provide recommendations to address them.

The U.S. Navy (Navy), the lead agency for JPHC/NHB, is preparing this 5-year review report pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] Part 300). CERCLA Section 121 states the following:

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

The Naval Facilities Engineering Command Northwest (NAVFAC NW) has conducted this 5-year review of the remedial actions implemented at JPHC/NHB. The review was conducted from August through December 2009, and this report documents the results of the review. The lead agency for cleanup at JPHC and NHB is the U.S. Environmental Protection Agency (EPA). As the primary tribal stakeholder, the Suquamish Tribe is given the opportunity to review and comment on documents prepared by the Navy related to CERCLA actions at JPHC/NHB.

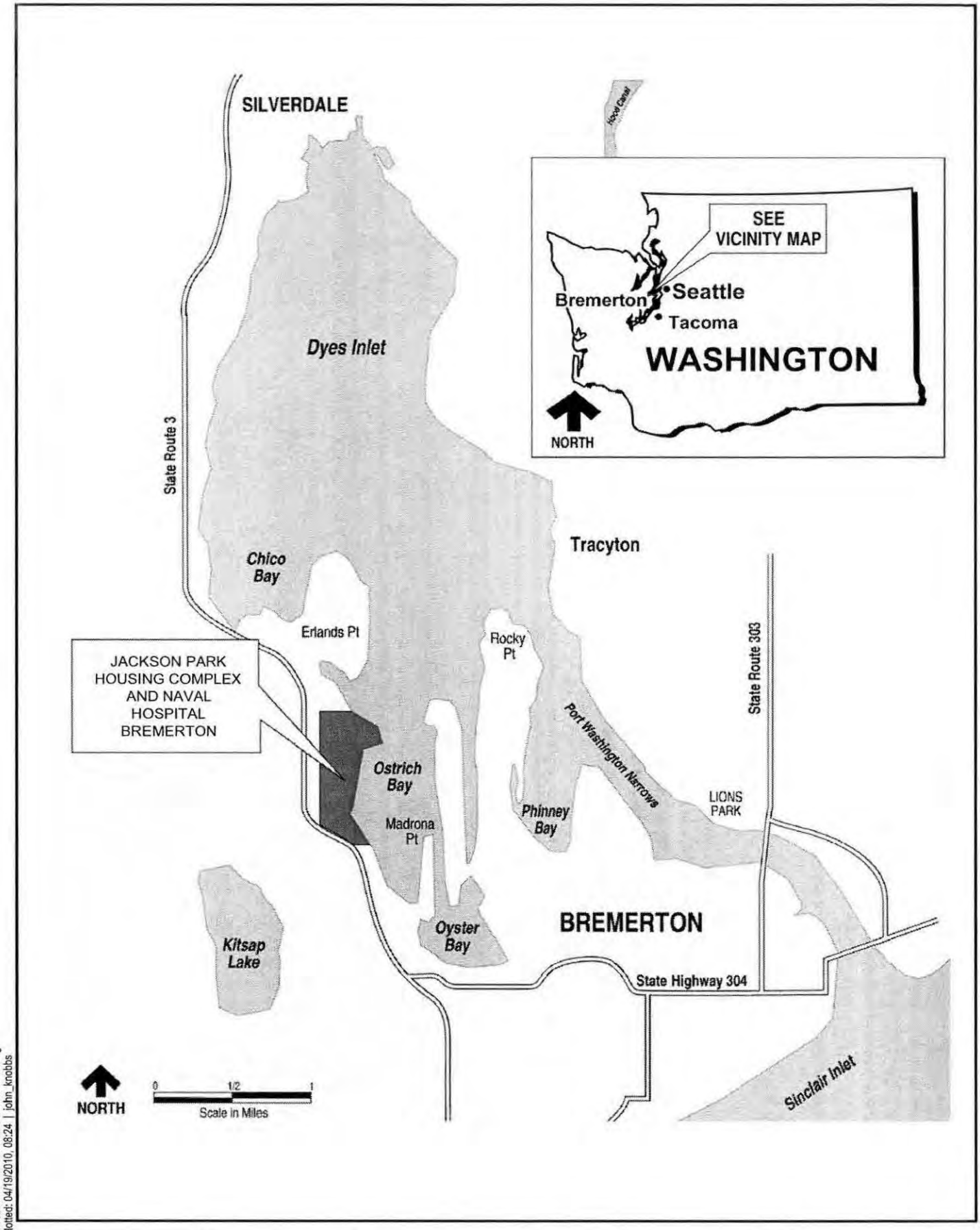
This report covers the remedies selected in the signed ROD for Operable Unit 1 (OU 1) (U.S. Navy, Ecology, and USEPA 2000). There are two additional OUs at JPHC/NHB, OU 2 and OU 3. OU 1 (Figures 1-1 and 1-2) addresses the terrestrial portions of the site as well as all human health risks. OU 1 at JPHC/NHB consists of five sites: 101, 101-A, 103, 110, and Benzene Release Area. OU 2 consists of marine sediments in Ostrich Bay and any associated ecological risks to the marine environment. OU 3 addresses discarded military munitions

(DMM) that may be present on JPHC/NHB property or in Ostrich Bay. OU 3 is divided into subunits to allow separate considerations of all munitions issues by geographical area and environment, both terrestrial (T) and marine (M). The three OU 3 subunits are OU 3T-JPHC, consisting of terrestrial (or "upland") areas, including the entire housing complex; OU 3T-NHB, consisting of terrestrial areas that include the NHB property; and OU 3M, consisting of subtidal areas of Ostrich Bay to the east of OU 3T-JPHC. OU 3T-JPHC and OU 3T-NHB include all portions of JPHC/NHB located above the 0-foot mean lower low water (MLLW) line. OU 3M addresses munitions in Ostrich Bay below 0 foot MLLW where contamination is located.

This is the second 5-year review for JPHC/NHB. The triggering action for this review was the previous 5-year review, executed by the Navy on October 27, 2005. The triggering action date in EPA's records is May 11, 2006. Contaminants have been left at JPHC/NHB above levels that allow for unlimited use and unrestricted exposure.

The ROD documenting the remedies implemented at JPHC/NHB OU 1 was signed after October 17, 1986. Therefore, this is considered a statutory, rather than a policy, review. Separate RODs, currently under development, will be issued for OU 2 and OU 3.

This report was prepared as part of the CERCLA 5-year review process using Navy and EPA guidance (USEPA 2001 and U.S. Navy 2004a).



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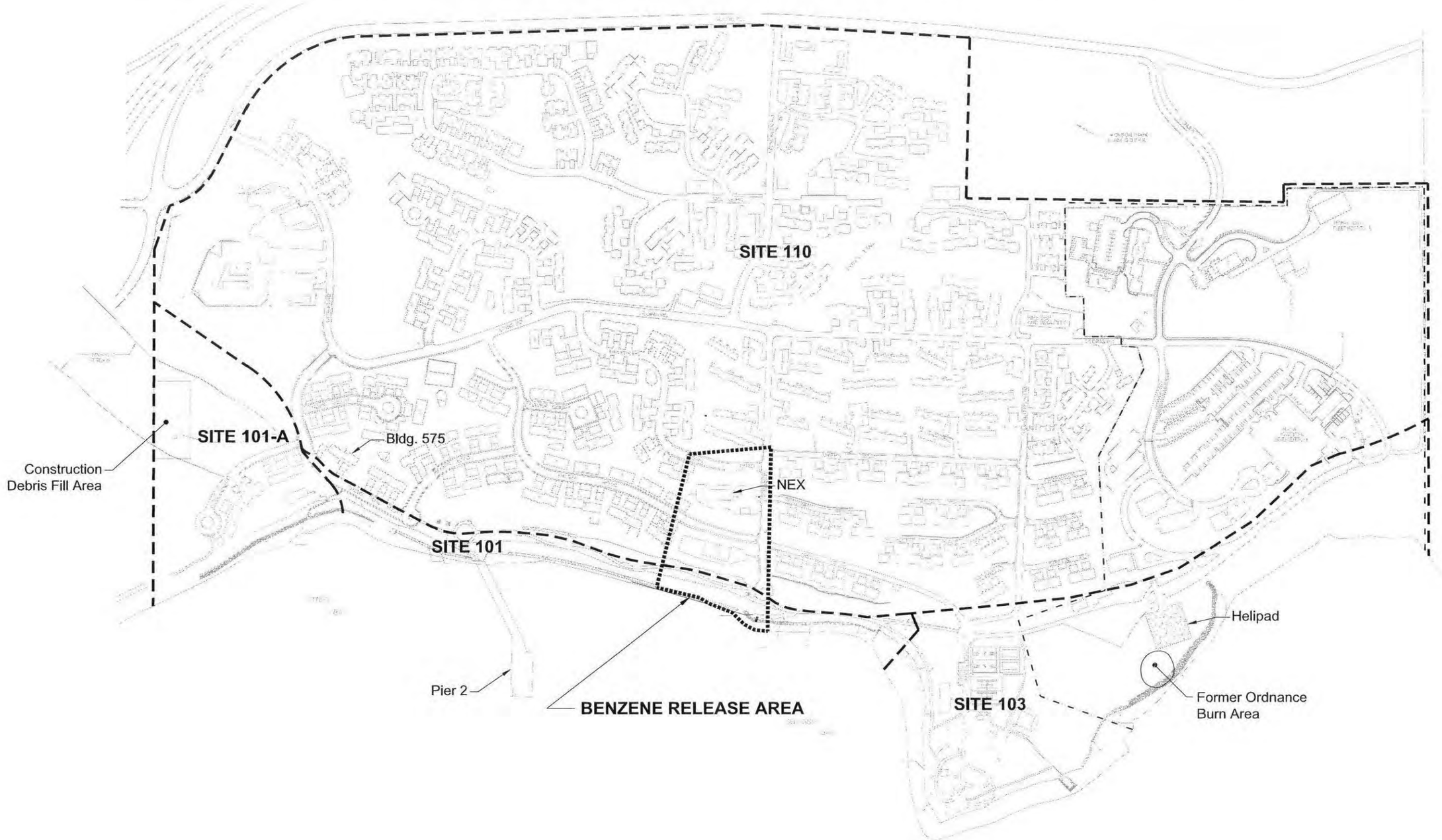
U.S. NAVY		**Figure 1-1** **Vicinity Map**	JPHC/NHB SECOND FIVE-YEAR REVIEW



LEGEND

Site Boundary Line

Naval Hospital Property Line

U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 200 400 SCALE IN FEET	**Figure 1-2** **Operable Unit 1 Site Divisions**

T:\NAVY\Jacks_pk\IDIQ\DO 6412nd 5 Yr Review\FIG 1-2 SITE AREAS.dwg
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2.0 SITE CHRONOLOGY

The substantive events in the chronology of JPHC/NHB related to site discovery, investigation, and remediation are listed in Table 2-1 and summarized in narrative form in the remainder of this section.

In 1981, EPA identified JPHC/NHB as a potential site where hazardous substance may have been released to the environment. The Navy conducted preliminary assessments at JPHC/NHB beginning in 1983 (U.S. Navy 1983 and 1988).

A site inspection was conducted at Site 110 in 1993 and the results documented in a site inspection report (U.S. Navy 1994e). The Navy used the results of this report to conduct several removal actions at Site 110 (see Section 3.4). Based on the results of the site inspection and the removal actions that have taken place, the Navy and the State of Washington determined that a formal remedial investigation (RI) and risk assessment were not warranted at Site 110.

In 1994, EPA placed JPHC/NHB on the NPL. The NPL is designed to categorize, rank, and expedite investigation and cleanup of the nation's primary hazardous waste sites.

The Navy and the State of Washington determined that RI work was warranted at Sites 101, 101-A, and 103. Three phases of field work were conducted. The results of Phase I terrestrial and marine investigations were documented in the JPHC/NHB final Phase I RI report (U.S. Navy 1994b). The Phase I RI concluded with specific recommendations to collect additional data for the terrestrial and marine environments. The additional data collection was considered Phase II and was performed in two separate tasks. The Phase II terrestrial data collection was performed in December 1993 and the Phase II marine data collection in July 1994 (U.S. Navy 1994d and 1995a).

In May 1995 to expedite remedial actions, the Navy administratively separated the site into OU 1, which addresses the terrestrial environment, and OU 2, which addresses the marine environment. Human health risks, including terrestrial and marine exposures, are addressed in OU 1. The final Phase II OU 1 supplemental RI report (U.S. Navy 1995a) summarized the terrestrial findings from the Phase I RI and the findings from the Phase II terrestrial investigation.

After completion of the final Phase II supplemental RI report, additional field work (referred to as Phase III) was conducted in August 1996. The Phase III investigation was designed to address specific data gaps associated with surface water seeps and outfalls along the Ostrich Bay shoreline and with a former waste burning area near NHB. The final feasibility study (FS) for JPHC/NHB was issued in April 1998 (U.S. Navy 1998b), incorporating all data collected through 1997 (Phases I, II, and the initial portion of III).

Phase III field work and data analysis continued after publication of the final FS. Several additional studies were conducted at OU 1 between 1997 and 1999. One result of these investigations was the discovery of the source of the Benzene Release Area in 1998. Also during this time, munitions-related investigations under CERCLA began (in 1998). In the summer of 2000, the Navy designated a third operable unit, OU 3, with both marine and terrestrial components, to address all potential munitions-related issues.

The ROD for OU 1 was signed on August 10, 2000.

An Interagency Agreement was established on November 1, 2004, between the Navy and EPA (U.S. Navy and USEPA 2004). The general purposes of the Interagency Agreement were the following:

- Ensure that the environmental impacts associated with past and present activities at the site were thoroughly investigated and appropriate remedial action taken as necessary to protect the public health, welfare, and the environment
- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at the site in accordance with CERCLA, the NCP, Superfund guidance and policy, Resource Conservation and Recovery Act (RCRA), and RCRA guidance and policy
- Facilitate cooperation, exchange of information, and participation of the parties in such actions

Post-ROD activities at the site are described in Sections 4 and 6.

Table 2-1
Chronology of Events

Event	Date
Site-Wide	
Discovery and preliminary assessment	1983
Site inspection (Site 110)	1993
Placed on National Priorities List	1994
Phase I RI report	1994
Phase II RI reports	1994, 1995
Separation of site into OU 1 and OU 2	1995
Site-wide FS	1998
OU 3 established	2000
Interagency Agreement established	2004
First 5-year review	2005
OU 1	
Record of Decision for OU 1	2000
Remedy construction complete for OU 1	2003
OU 2	
RI/FS	1998
Final closeout report (data summary for decision making)	2002
OU 3	
Preliminary assessment/site inspection	2003
Munitions clearances and removal actions	1959-2006
Terrestrial Phase 1 RI activities	2003-2004
Marine Phase 1 RI/FS work plan and RI activities	2006
Terrestrial Phase 2 RI activities	2007
Terrestrial Naval Hospital Bremerton action memorandum	2008
Marine Phase 2 RI/FS work plan	2009

Notes:
FS - feasibility study
OU - operable unit
RI - remedial investigation

3.0 BACKGROUND

JPHC/NHB is located in eastern Kitsap County, approximately 2 miles northwest of Bremerton, Washington (Figure 1-1). The JPHC/NHB site occupies approximately 206 acres on a sloping hillside bordering Ostrich Bay. The housing area itself comprises about 158 acres, with the naval hospital occupying the rest of the site. Ostrich Bay is part of the Puget Sound marine environment. The JPHC/NHB properties are bounded to the north by the community of Erlands Point, to the west by State Route 3, and to the south by a City of Bremerton park. The topography slopes from a maximum elevation of 180 feet above mean sea level at the west edge down to a relatively flat shoreline area along Ostrich Bay. Much of JPHC/NHB is developed as high-density residential housing for Navy personnel and dependents. Drinking water for OU 1 is supplied by the City of Bremerton public water system.

JPHC/NHB is the site of the former Naval Magazine Puget Sound (Naval Magazine), which was established in 1904 as an ammunition depot to store ordnance. Operations expanded during World War I to include ordnance manufacturing and processing, projectile loading and cleaning, and ordnance demilitarization.

The Naval Magazine became the U.S. Naval Ammunition Depot (NAD) Puget Sound around 1916. After World War I, the name was changed to NAD Bremerton. Operations at NAD Bremerton were stepped up during World War II. After the end of World War II, the facility's primary role shifted to ordnance demilitarization.

In 1948, command of NAD Bremerton was transferred to Bangor, and NAD Bremerton was renamed the Bremerton Annex. By 1959, the ammunition depot was no longer needed at the property and the area was placed under caretaker status. The annex was closed, but remained Navy property. Portions of the former depot property were then conveyed to Kitsap County, the City of Bremerton, and the State of Washington. Beginning around 1965, a portion of the remaining property was converted to military housing and renamed the Jackson Park Housing Complex. As housing construction continued in the early 1970s, the Navy demolished most of the remaining depot structures at the site. Around 1981, a gas station was added to the Navy Exchange (NEX) convenience store located within JPHC. Construction of additional housing at the site continued into the 1990s. Naval Base Kitsap (NBK) is the current owner of JPHC.

In May 1995, the site was divided into OU 1, to address the terrestrial environment and human health risk for both the terrestrial and marine environments, and OU 2, to address the ecological risk to the marine environment. OU 3 was added in 2000 to address the abandoned ordnance in both the marine and terrestrial environments. The 2004 Interagency Agreement divides OU 3 into subunits to allow separate considerations of all munitions issues by geographical area and environment, both terrestrial (T) and marine (M). The three OU 3 subunits are OU 3T-JPHC,

consisting of terrestrial (or "upland") areas, including the entire housing complex; OU 3T-NHB, consisting of terrestrial areas that include the NHB property; and OU 3M, consisting of subtidal areas of Ostrich Bay to the east of OU 3T-JPHC. OU 3T-JPHC and OU 3T-NHB include all portions of JPHC/NHB located above the 0-foot MLLW line. OU 3M addresses munitions in Ostrich Bay below 0-foot MLLW where contamination is located.

OU 1 consists of four sites: Sites 101, 101-A, 103, and 110 (Figure 1-2). A fifth site, the Benzene Release Area, overlaps Sites 101 and 110 and was discovered after the FS, but was included in the ROD. It is discussed here as a separate site. The subsections below provide a description of each of the sites at JPHC/NHB, including physical characteristics, land and resource use, the history of contamination, any removal actions performed prior to the signing of the ROD, and the basis for taking remedial action.

One time-critical removal action (TCRA) has occurred at OU 3 and is summarized in Section 3.7. The TCRA was completed as part of the (then) OU 1.

OU 2, OU 3T-NHB, and OU 3M are in the RI/FS phase of the CERCLA process. A ROD is under development for OU 3T-JPHC.

3.1 SITE 101

Site 101 includes a strip of shoreline approximately 2,400 feet long and 200 feet wide and is located primarily east of South Shore Road along Ostrich Bay up to Elwood Point. The historical industrial processes at Site 101 included ordnance production and destruction (demilitarization), storage of ordnance, and recycling and disposal of ordnance wastes. Waste ordnance (explosive dry powders) was produced daily in the loading and sifting buildings. The rooms in the loading and sifting buildings were rinsed with water daily to prevent the explosive powders from accumulating and forming an explosive atmosphere. Most liquid wastes were flushed into tile drains and discharged directly to Ostrich Bay. Some waste liquids were removed from the waste stream and transported by truck to a recycling processing area on site.

Investigations conducted in 1992 revealed diesel and motor oil contamination in subsurface soils immediately east of Building 575 (originally referred to as Building 91), along South Shore Road. Building 575 is a housing unit located in Site 110, along the Site 101/Site 110 border. The area of contaminated soil extended across site borders to include portions of Site 110, 101, and 101-A. The petroleum contamination in the soil was likely caused by releases from former NAD Building 67 (an industrial building) and/or former NAD Building 122 (a boiler house/fuel pumping facility). Buildings 67 and 122 were demolished prior to construction of the housing units.

Soil removal was conducted from September 1993 through February 1994. The area of soil excavation was east of Building 575 in portions of Site 101 and 101-A. The excavation included removal of the buried foundation of former NAD Building 122. Confirmation sampling conducted in the excavation indicated levels of total petroleum hydrocarbons (TPH) below the Model Toxics Control Act (MTCA) cleanup level in two of six sampling locations (U.S. Navy 1994a). Contaminated soils were left in place beneath Building 575 to ensure the structural stability of the building. Engineered backfill designed for low permeability was used to fill the excavation. This design, together with the natural underlying glacial till, was intended to decrease the likelihood that the small amounts of remaining contamination would migrate to groundwater.

The human health risk assessment conducted for the site found unacceptable risks to current and future residents from exposure to soil, sediment, and marine tissue. The chemicals of concern (COCs) for soil were carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and arsenic; the COC for sediment was arsenic; and the COCs for marine tissue were antimony, 3,3'-dichlorobenzidine, pentachlorophenol (PCP), and vanadium (future residents only).

Groundwater in glacial outwash deposits (Vashon Recessional Outwash) in the nearshore portions of OU 1 (all of Sites 101 and 103 and the majority of Site 101-A) is a zone of perched groundwater above the Vashon Till, a layer of relatively impermeable glacial till. This groundwater is not a potential source of drinking water because there is insufficient yield to support drinking water wells. A number of chemicals detected in groundwater did have concentrations exceeding drinking water standards. However, the basis for remedial action is the concentrations of chemicals that exceed cleanup criteria protective of the marine environment (nearest surface water body) at the point where groundwater enters the marine environment. At Site 101, four chemicals detected in seeps and outfalls in at least one sample prior to the signing of the ROD exceeded cleanup criteria: benzene, arsenic, mercury, and nickel. Two of these chemicals, mercury and nickel, were found by the ecological risk assessment to be an ecological hazard.

3.2 SITE 101-A

Site 101-A lies to the south of Site 101 and includes approximately 880 lineal feet of shoreline and 7 acres of adjacent uplands. The site includes a former construction debris landfill and the housing area around Root Court to the edge of Ostrich Bay (Root Court is the most southeastern portion of the housing complex). Historical industrial processes associated with Site 101-A include ordnance production and demilitarization and ordnance sifting and loading. An incinerator and a boiler house were also present at Site 101-A. Demilitarization used high temperature and steam. As described for Site 101, rooms in the loading and sifting buildings were rinsed with water daily to prevent accumulation of explosive materials. The liquid wastes

were flushed into tile drains and discharged directly to Ostrich Bay. The shoreline area was backfilled during the construction of the Naval Magazine (early 20th century) and housing units (1970s).

Six underground storage tanks (USTs) and some associated pipes and fuel distribution lines were removed from Site 101-A in 1993. All petroleum-impacted soils were removed from beneath four of the tanks along with the tanks (U.S. Navy 1994c). Soil and groundwater beneath the other two tanks were found to be contaminated with petroleum hydrocarbons. Petroleum-contaminated soil above groundwater was removed from these excavations, but soil beneath the water table containing petroleum hydrocarbons above the MTCA Method A cleanup level was not removed. An engineered backfill on top of geotextile fabric was designed to contain any remaining contamination by decreasing the permeability of the soil. After the excavation was complete, samples of downgradient wells indicated no migration of petroleum hydrocarbons through the groundwater (U.S. Navy 1994c).

An additional source of contamination in Site 101-A was structural debris from ordnance storage bunkers at Site 110, which was disposed of in a debris fill area south of Root Court (Figure 1-2).

The human health risk assessment conducted for the site found unacceptable risks from exposure to soil, sediment, and marine tissue to current and future residents. For soil, the COCs were cPAHs and beryllium; for sediment, the COC was arsenic; and for marine tissue, the COCs were antimony, 3,3'-dichlorobenzidine, and PCP.

As with Site 101, groundwater beneath Site 101-A is not a drinking water source because of insufficient yield from the perched aquifer, and the basis for remedial action is protection of the marine environment. At Site 101, two chemicals detected in seeps and outfalls in at least one sample prior to the signing of the ROD exceeded cleanup criteria: arsenic and mercury. Mercury was identified in the ecological risk assessment as a major risk contributor.

3.3 SITE 103

Site 103 consists of a low, flat promontory referred to as Elwood Point and approximately 500 feet of shoreline to the east of the hospital. The site includes a helicopter pad, recreation fields, playing courts, a picnic area, and, formerly, a railroad transfer pier. The land ownership of Site 103 is split between the housing complex and the hospital (Figure 1-2). The historical industrial processes and facilities associated with Site 103 were maintenance of locomotives, sand-blasting, military and civilian housing, barracks, a cafeteria, latrines, paint and oil storage, and a railroad transfer pier. Ordnance wastes were burned on a concrete slab on the north side of Elwood Point, and trash was burned in an area farther north along the shoreline of the site

(Figure 1-2). An incinerator was also present at Site 103. Landfilling took place from 1910 to 1959 and included sands, gravels, and artificial materials such as concrete and metal debris.

In 1998, significant erosion was occurring along the north shore of Site 103, near the helipad.

The erosion threatened a potential release into the marine environment of contaminants present in fill material. A removal action was conducted to temporarily prevent further erosion along approximately 75 feet of shoreline. The removal action included excavating the bank back to a slope of approximately 3H: 1V, armoring the slope with rock, and covering the area with a gravel mix to act as a sacrificial material during storm events.

The human health risk assessment conducted for the site found unacceptable risks from exposure to soil, sediment, and marine tissue to current and future residents. COCs for soil were cPAHs, arsenic (current residents), and polychlorinated biphenyls (PCBs) (future residents); the COC for sediment was arsenic; and the COCs for marine tissue were antimony, vanadium (future residents only), 3,3'-dichlorobenzidine, and PCP.

As with all the shoreline areas of OU 1, groundwater beneath Site 103 is not a drinking water source, and the basis for remedial action is protection of the marine environment. At Site 103, six chemicals detected in seeps and outfalls in at least one sample prior to the signing of the ROD exceeded cleanup criteria: arsenic, mercury, silver, 1,1-dichloroethene (1,1-DCE), trichloroethene (TCE), and vinyl chloride. Mercury and silver were identified in the ecological risk assessment as major risk contributors.

3.4 SITE 110

Site 110 includes the majority of JPHC/NHB. Figure 1-2 shows that the northern portion of Site 110 is owned by NHB and the southern portion is part of the JPHC property. Historical activities at Site 110 primarily consisted of ordnance production and storage of ordnance and inert materials. Six bunkers were originally used for ordnance storage at the site. Four of the bunkers are being used for storage, and the remaining two have been demolished. Ordnance wastes were found in at least 13 of the structures (including the ordnance storage bunkers) that were removed during demolitions in the early 1970s. Buildings most heavily used for ordnance were steam-cleaned prior to demolition. In 1959, all explosives were moved from the bunkers to NAD Bangor. Levels of lead, arsenic, and cPAHs in soil exceeded the MTCA Method A cleanup levels for residential surface soil near four of the six bunkers (U.S. Navy 1994e). The affected bunkers were Buildings 100, 101, 103, and 104. Between August 1994 and June 1995, the soils containing contamination above MTCA Method A cleanup levels for residential surface soil, including an area within the Jackson Park Elementary School yard, were excavated and properly disposed of. However, arsenic concentrations above the MTCA Method A cleanup level of

20 mg/kg remain in soil underneath paved areas in front of two of the bunkers (Buildings 100 and 101) (U.S. Navy 1995b). The highest remaining arsenic concentration beneath the pavement is 273 mg/kg. The pavement serves as a barrier to prevent human exposure to these soils.

During construction of new homes at JPHC in 1995, a disposal site was discovered at the northeast corner of Olding and Elwood Point Roads. Drums uncovered by the housing construction contractor were sampled and the contents determined to be petroleum products and lime wastes. Samples of materials removed from the disposal site confirmed the presence of asbestos in pipe insulation, petroleum products and lime waste in the drums, petroleum contamination in soils, and creosote-PAH compounds in timber. In March 1995, all waste and contaminated soil were removed and disposed of. Confirmation samples collected from the excavation prior to backfilling reported no petroleum detections above MTCA Method A soil cleanup levels (U.S. Navy 1995b and 1995c).

Four USTs were removed from Site 110 in 1996. The tanks probably stored fuel oil and diesel fuel. There were no records of installation date, cathodic protection, or tank tightness for any of the USTs. All four tanks were found in good condition with little corrosion and no holes or damage. The tanks and all associated petroleum-contaminated soil were removed and disposed of properly (U.S. Navy 1996a, 1996b, 1996c, and 1996d).

Based on the removal actions that have taken place, the Navy and the State of Washington determined that a formal RI report and risk assessment were not warranted at Site 110.

Groundwater in the upper portion of Site 110 occurs in the Vashon Advance Outwash deposits (beneath the Vashon Till), a regionally important aquifer. Groundwater within this aquifer is potable. However it is not being used for drinking water at JPHC/NHB, nor is it likely to be in the future. The nearest domestic wells are 0.75 mile from the site and are upgradient of JPHC/NHB. The basis for remedial action for upland Site 110 groundwater is chemical exceedances above drinking water criteria. Five metals, arsenic, beryllium, manganese, nickel, and vanadium, have been detected above drinking water criteria in at least one groundwater sample.

3.5 BENZENE RELEASE AREA

The Benzene Release Area is located within Sites 101 and 110. The area is defined by two seeps that discharge through pipes along the shore of Ostrich Bay and an upgradient area of known soil or groundwater contamination that extends approximately 450 feet upgradient of the seeps.

Seep sampling at Site 101 identified one shoreline outfall that was discharging water containing benzene and petroleum above state cleanup levels. In 1996, Washington State Department of Ecology (Ecology) conducted an independent investigation of seeps and groundwater in this area. In 1997 and 1998, a second investigation was conducted by the Navy in an attempt to determine the source and extent of benzene and petroleum contamination in upgradient soil and groundwater. The results of these investigations were reported in the draft benzene release investigation report (U.S. Navy 1998a). However, no source of contamination was identified. In November 1999, additional field work was conducted. This third benzene release investigation identified a source of the benzene and petroleum contamination near the fuel dispenser island at the NEX gas station located at Dowell Road and Sullivan Place within the boundaries of Site 110.

Groundwater beneath the Benzene Release Area exists both as perched groundwater (as described for Site 101, it cannot be used for drinking) and deeper groundwater beneath the Vashon Till. At the time the ROD was signed, it was thought that deeper groundwater had not been impacted. Therefore, the basis for remedial action is protection of the marine environment, and the chemicals in seeps and outfalls (located in Site 101) that exceed surface water criteria are TPH-gasoline (TPH-G) and benzene. The issues associated with the deeper groundwater are discussed further in Sections 4 and 6 of this report. No risk assessment was conducted for the Benzene Release Area.

3.6 OPERABLE UNIT 2

OU 2 of the JPHC/NHB site consists of marine sediments in Ostrich Bay, which lies at the southern end of Dyes Inlet in Puget Sound, Washington. The bay is approximately 0.5 mile wide and varies in depth from tidally exposed areas near the shoreline to approximately 12 meters deep in the center. Immediately east of OU 2 is the Port Washington Narrows, a constricted inlet that enables tidal exchange with central Puget Sound. Erland Point separates the bay from Dyes Inlet. Ostrich Bay is bordered on the west by JPHC/NHB and on the south and east by the City of Bremerton and is surrounded by suburban and rural development. OU 2 includes Navy-owned property extending out from the shoreline to a distance where the water depth is 24 feet at MLLW. The remaining property in Ostrich Bay is managed by the State of Washington (Department of Natural Resources) or is privately owned.

Because many historical operations at the Depot may have resulted in the discharge of wastes containing munitions-related compounds, these operations were suspected to have an impact on sediment quality in the bay. RIs were conducted at OU 2 from 1991 to 1998. The Phases 1 and 2 RI identified widespread exceedances of the state Sediment Management Standards (SMS) for mercury. A treatability study (April 1998) was subsequently undertaken to fill the data gaps identified in the draft RI report and to provided further data on sediment dynamics in the bay and

in Dyes Inlet, and on chemical and toxicological characterization of Ostrich Bay sediments. The final RI report (July 1998) incorporated the results of the Phases I and II RI reports and the treatability study. Sediment chemical analysis for the Ostrich Bay study identifies areas with low levels of metals contamination (mercury, cadmium, and lead) and trace concentrations of organic compounds, pesticides, PCBs, and dioxins. Sediment toxicity was discovered during all phases of the RI and treatability studies, although not consistently. Exceedances of SMS for benthic bioassays were found only for echinoderm larval bioassay during the treatability study, although exceedances of SMS were observed for both echinoderm larval and amphipod bioassays during the Phase II RI. Sediment toxicity failures have not been associated with any specific chemical, including munitions degradation compounds. The Navy believed toxicity was the result of potential influences of confounding factors in the toxicity test. EPA and Ecology did not agree.

An FS was completed in 1998. The preliminary OU 2 remedial action objective (RAO) was to reduce the ecological risk in the marine environment in Ostrich Bay. Alternatives included no action, natural recovery, enhanced natural recovery, and sediment capping. A closeout report was issued in 2002 to summarize the technical information related to the site and for use in making remedial decisions. The Navy subsequently prepared draft proposed plans for remedial action for review by stakeholders, with the latest submitted in February 2005 (U.S. Navy 2005b). The Navy concluded that while near-shore sediments contained low levels of munitions-related compounds, the majority of sediment contamination in Ostrich Bay was likely associated with the transport of metals-contaminated sediments into the bay from Dyes Inlet and other sources. The stakeholder group did not concur with the Navy's draft proposed plans and the Navy and EPA entered an informal dispute regarding the remedy. The informal dispute identified data gaps in the RI regarding impact of munitions compounds not historically analyzed. These data gaps called into question the decision not to conduct a baseline ecological risk assessment. The Navy agreed to conduct a supplemental RI to address the data gaps and complete a full ecological risk assessment. The supplemental RI sampling was completed in December 2009 and the risk assessment report is currently scheduled to be complete by July 2010.

3.7 OPERABLE UNIT 3

For all of the OU 1 remedial actions described in Section 4, screening and clearance of DMM occurred prior to any remedial activities for the terrestrial and marine portions of the site, as required by local instructions concerning dig permitting and oversight of ground disturbing activity at the time the work was performed. Any actions related to investigation and cleanup of DMM to address potential explosive safety hazards at the site are now considered part of OU 3.

The 2004 Interagency Agreement divides OU 3 into subunits to allow separate considerations of all munitions issues by geographical area and environment, both terrestrial (T) and marine (M). The three OU 3 subunits are OU 3T-JPHC, consisting of terrestrial (or "upland") areas, including the entire housing complex and all intertidal area managed by the Navy to the mean low-low water level; OU 3T-NHB, consisting of terrestrial areas that include the NHB property and no intertidal area; and OU 3M, which addresses explosive hazards associated with military munitions in subtidal areas of Ostrich Bay (i.e., below the mean low-low water line).

OU 3 investigation and cleanup actions have included the following (U.S. Navy 2010a):

- Navy explosive ordnance disposal (EOD) operations as part of facility operations and construction activity from 1959 to 1998
- Joint contractor/EOD operations from 1998 to 2006 as part of a pre-RI, TCRA, as part of the OU 1 ROD implementation, and as part of ongoing facility reconstruction operations
- An RI at JPHC from March 2003 to December 2007
- An RI at NHB from August 2007 to April 2009
- A TCRA-mound removal at NHB from August 2008 to March 2009
- An ongoing unexploded ordnance screening as a part of the Dig Permit process at NHB

The TCRA conducted between September 1999 and December 2001 involved DMM clearance ahead of construction and included investigation of 2,475 anomalies to a depth of 2 feet over 11.7 acres (including the ball field on the NHB property). Five DMM containing high-explosive items were recovered. A total of 4,589 other munitions-related items were also found, ranging from DMM not containing high explosives (e.g., small arms) to munitions and explosives of concern scrap. The screened soil was returned and an additional 1-foot soil cap was placed over a 9-acre area. The site, except areas designated for pavement, was then covered with a 4- to 6-inch layer of topsoil and sod (U.S. Navy 2010a).

A draft RI/FS report for OU 3M is planned for June 2010.

Phase I RI activities for OU 3T-JPHC were conducted in 2003 and 2004. Phase 2 RI activities were completed in 2007. Results of the Phase 2 RI investigation are presented in the final OU 3T RI/FS report (U.S. Navy 2010a). The conclusions of the RI can be summarized as follows:

- More than 9,400 separate locations were investigated (excavated) during the investigation, and from these locations, more than 23,000 metallic items were removed from the subsurface.

- During the investigation, two DMM items containing high explosives were discovered. Neither of these items was fired or armed.

- Based on the results of the investigation, the explosive hazard presented by the site has been determined to be low by Naval Ordnance Safety and Support Activity (NOSSA) and by a hazard assessment performed using the Munitions and Explosive of Concern Hazard Assessment (MECHA) model developed by EPA.

- Based on the assessment of explosive hazards at the site, the Navy is recommending continued education and awareness programs as an important component of the final remedy to address the low degree of explosive hazard posed by the site.

Based on the final OU 3T RI/FS report, a preferred final remedy will be presented in a proposed plan. Pending public comment on the proposed plan, a final ROD concerning remediation requirements for OU 3T-JPHC is expected in 2011.

The RI for OU 3T-NHB was completed in spring of 2009. The investigation approach used was consistent with the OU 3T-JPHC investigation. During this investigation, no DMM item with high explosive was found at the site. A debris mound containing more than 300 canisters of "flashless pellets" was discovered during the OU 3T-NHB RI. These flashless pellets were used as an additive to naval gun propellant and were determined not to present an explosive hazard. An action memorandum regarding OU 3T-NHB was issued August 29, 2008 that documented a decision to perform a TCRA consisting of excavating this debris mound along the NHB shoreline where the flashless pellet canisters were found. Subsequent testing determined that the pellets were an oxidizer, and they were thermally treated. A draft version of the OU 3T-NHB RI/FS was submitted to EPA in March 2010 (U.S. Navy 2010b). A ROD for OU 3T-NHB is scheduled for 2011.

In advance of a ROD for OU 3T-JPHC, land use controls are in place to prevent the public from encountering potential munitions items or chemicals associated with munitions. The current land use controls, updated in 2008, include the following:

- NBK Instruction 8020.1A, *Implementation of Land Use Controls Applicable to Explosive Hazard Management at JPHC*, dated June 18, 2008, requires residents, contractors, and others performing ground disturbing activities at JPHC to complete munitions education and awareness training.
- The NBK Public Works Department manages the JPHC/NHB Dig Permit Program through the Base Operating Support Contractor.
- The Munitions Awareness Program supplies children's coloring books, videos, and posters to the public. These materials provide information on the appropriate steps to the take if a suspect item is encountered.
- The beach below JPHC/NHB has signs located along the shore that state that clam digging and shellfish harvesting are prohibited in the area.
- The Coast Guard maintains a Notice to Mariners, which advises caution in the marine area near existing piers at JPHC/NHB.

NBK Instruction 8020.1A includes a procedure for annual review of the land use controls and reporting of the results.

4.0 REMEDIAL ACTIONS

The ROD for OU 1 at JPHC/NHB required remedial action at four sites identified during the RI/FS (Sites 101, 101-A, 103, and 110) and one area discovered after the RI/FS (the Benzene Release Area). For each of these areas, this section provides a summary of the RAOs, a description of the selected remedy, and a summary of remedy implementation, maintenance, and monitoring.

The overall RAOs for OU 1 are as follows:

- Prevent dermal contact with or ingestion of soil containing concentrations of COCs above state cleanup levels.
- Verify that concentrations of inorganics in Site 110 groundwater are below background levels or state and federal drinking water applicable or relevant and appropriate requirements (ARARs).
- Reduce the potential for erosional transport of chemicals in soil to the marine environment.
- Protect ecological receptors in the marine environment and human health by attaining compliance with water quality standards for marine surface water at the point of groundwater discharge.
- For shellfish from Ostrich Bay, reduce risks from subsistence-level ingestion to less than 1×10^{-5} excess carcinogenic risk, or less than a noncarcinogenic hazard index (HI) of 1.

4.1 SITE 101

4.1.1 Remedy Selection

The COCs in soil at Site 101 were cPAHs and arsenic (U.S. Navy, Ecology, and USEPA 2000, Table 7-7), and COCs in groundwater at the point where groundwater enters the marine environment were arsenic, mercury, nickel, and benzene (see also Section 3.1).

To achieve RAOs, the remedial action components selected in the OU 1 ROD include the following:

- A vegetated cover consisting of a minimum 1-foot-thick soil cover plus sufficient topsoil to support vegetation installed over the identified areas where COCs in surface soils exceeded the remediation goals (RGs).

- Shoreline stabilization measures were to be installed along the shoreline to limit erosion of soils that may contain COCs. Along the entire JPHC/NHB shoreline (includes areas of Sites 101-A and 103), anthropogenic debris that was present in shoreline and intertidal areas was to be removed and properly reused, recycled, or disposed of.

- Regular inspection and maintenance of the shoreline stabilization measures and soil covers were to be conducted and documented. The inspections also were to occur after major storm events. Physical maintenance was to be provided as needed.

- Permanent restrictions were to be placed on the property by the Navy to limit or prevent activities that could disturb the engineered soil cover over the impacted soil between South Shore Road and Ostrich Bay.

- Permanent restrictions were to be placed on the property by the Navy to prevent construction of drinking water wells in the uppermost water-bearing unit. These restrictions apply to shallow groundwater above the Vashon Till.

- For the designated intertidal areas and adjacent shoreline owned by the Navy, land use restrictions were to be implemented to address procedures for controlling construction and maintenance activities to prevent activities that may interfere with or compromise the function of the shoreline stabilization system. The restrictions were to include requirements for ongoing monitoring and maintenance of the shoreline stabilization system.

- A shellfish sampling program was to be implemented. The Navy, with concurrence from EPA, Ecology, and the Washington State Department of Health decide when shellfish on JPHC/NHB beaches can be harvested and the purpose of those harvests, e.g., subsistence, recreational, commercial, or ceremonial gathering.

- Signs were to be posted along the shoreline to notify JPHC residents (and any members of the general public) of any harvest restrictions.

4.1.2 Remedy Implementation

Remedy implementation for Site 101 occurred primarily from June 2000 through June 2001. During this time, a soil cover was placed over the areas of impacted surface soil from the shoreline to west of Shoreline Road. Soil cover was at least 12 inches deep, and sod was placed on top of the fill. An indicator layer composed of black, square-hatched, polyethylene geotextile fabric was placed beneath the clean fill. The indicator layer was labeled with water resistant tags permanently attached to the fabric. The tags read "Caution. Contact commanding office prior to digging below this barrier."

Shoreline stabilization remedial actions occurred during the summer of 2000. Stabilization activities consisted of the following:

- Removal of miscellaneous debris on the shoreline
- Installation of a rock shelf from the southern edge of Site 101 up to Pier 2 and from the approximate terminus of Dowell Street up to the beginning of Site 103
- Slope stabilization with geotextile and vegetation in selected areas
- Seawall repair (from the stormwater outfall basin approximately 1,400 feet north to the sanitary sewer lift station)
- Installation of armor rock revetment and vegetation
- Construction of granite beach access stairs near the Dowell Street terminus
- Placement of shellfish harvesting restriction signs in several locations

4.1.3 Operation, Maintenance, and Monitoring

The operation, maintenance, and monitoring program for Site 101 specified by the ROD consists of fulfilling ROD-mandated monitoring requirements, managing the institutional controls program, and maintaining the remedies implemented for the site.

Monitoring

Long-term monitoring (LTM) of seeps and outfalls at Site 101 has been conducted since 2002, with semiannual sampling occurring the first year of sampling and annual sampling occurring thereafter, in accordance with the ROD. Therefore, sampling occurred in summer and fall of the first year, and in summer of the following years. An additional sampling round was conducted in

the fall of 2004 during an extreme low tidal cycle. Sampling of three seeps (SP-710, SP-711, and SP-713) and two outfalls (OF-709 and OF-712) are included in the monitoring program at Site 101, and samples from these locations were analyzed as follows:

- All samples were analyzed for total metals (arsenic, beryllium, mercury, and thallium), dissolved metals (copper, lead, nickel, silver, and zinc), and cyanide.
- Samples from OF-709 were analyzed for chlorinated volatile organic compounds (VOCs), including 1,1-DCE, TCE, and vinyl chloride.
- Samples from SP-710, SP-711, and OF-712 were analyzed for benzene.
- Samples from SP-710 and SP-711 were analyzed for gasoline-range organics (GRO) and diesel-range organics (DRO).

All Site 101 monitoring activities since the last 5-year review were performed in accordance with the LTM work plan (U.S. Navy 2002b), except as noted below. Five rounds of seep and outfall samples have been collected since the last 5-year review. However, samples have not been collected from location SP-711 since the last 5-year review because of insufficient flow at the seep, high salinity of the seep water indicating the seep water was not representative of site groundwater, or both. The current sampling schedule is shown in Table 4-1. LTM locations are shown on Figure 4-1. The results of seep and outfall monitoring at Site 101 are discussed in Section 6.4.

Marine tissue monitoring has also been conducted since 2002 as part of the LTM program for Site 101, as well as for sites 101-A and 103. Marine tissue, including clam and crab tissue, was sampled for antimony, arsenic, vanadium, 3,3'-dichlorobenzidine, pentachlorophenol, and ordnance compounds in 2002 and 2004 in accordance with the ROD and the LTM work plan (U.S. Navy 2002b). Based on recommendations made in the last 5-year review (U.S. Navy 2005c), the marine tissue monitoring program was revised with a reduced sampling frequency of once prior to each 5-year review. As a result, marine tissue samples were collected once, in 2009, since the last 5-year review. In addition, monitoring for ordnance compounds in the background samples was added to the monitoring program since the last 5-year review. To provide more detailed information regarding arsenic, the Navy also elected to add arsenic speciation to the analyte list for marine tissue sampling in 2009. The current sampling schedule is shown in Table 4-1. Marine tissue monitoring locations are shown on Figure 4-2. The results of shellfish monitoring in areas offshore of Sites 101, 101-A, and 103 are discussed in Section 6.4.

Institutional Controls

COCs in the groundwater beneath Site 101 are required to meet ROD RGs at the point where groundwater enters the marine environment (point of compliance). To this end, the Land Use Control Plan (U.S. Navy 2005a) specifies permanent restrictions to be placed on use of shallow groundwater (above the Vashon Till) as a drinking water source. In addition, the area of Site 101 where impacted soils are covered by the geotextile liner is an area where institutional controls regarding excavation and construction are required. Figure 4-3 shows the location of these controlled areas. Such controls have also been incorporated into the Land Use Control Plan (U.S. Navy 2005a). Compliance inspections of the areas shown on Figure 4-3 have been implemented as part of the Land Use Control Plan to ensure that the drinking water and excavation restrictions continue to function as planned.

Remedy Maintenance

Remedy maintenance inspections for Site 101 commenced in the spring of 2004 in accordance with the ROD, and inspections have been conducted as follows:

- Annual inspection of trees and shrubs in the shoreline area to determine whether trimming and pruning are required
- Semiannual inspection of the following:
  - The soil-based covers to ensure that soil covers have not been excavated, erosion is not occurring, and the vegetation is healthy
  - The asphalt, concrete, and stone-covered areas to ensure they are intact
  - The shoreline vegetation to ensure their survival
  - The mulch beds to ensure adequate mulch is in place
  - Stairways, low rock shelf, armor stone revetment, and pocket beach for erosion
  - The seawall to monitor for significant erosion, washouts, and failures
  - Drains and outfalls for significant erosion or blockage

- Quarterly inspection of the following:
  - The shoreline vegetation for weeds and to establish whether watering is needed
  - The low rock shelf and armor stone revetment to determine whether rocks have been removed
  - The shellfish harvest restriction signs to ensure that the signs are present and upright
- Inspection of remedial measures within 72 hours of a 2-year storm event

As a result of these inspections, various maintenance activities were performed as described in Section 6.4.7.

All Site 101 inspection and maintenance activities since the last 5-year review were generally performed in accordance with the inspection and maintenance plan (U.S. Navy 2003e) and the revised inspection and maintenance plan (U.S. Navy 2008b). Although the inspection and maintenance plan was revised in 2008, only minor changes were made to the inspection and maintenance program. To address newly planted vegetation, weekly watering was added for the summer of 2008 and as needed for 2009. The 2008 inspection and maintenance plan also identified the locations of newly placed shellfish harvest restriction signs. The current inspection and maintenance schedule is shown in Table 4-2. Inspection and maintenance activities are discussed further in Section 6.4.

4.2 SITE 101-A

4.2.1 Remedy Selection

The COCs in soil at Site 101-A were cPAHs and beryllium (U.S. Navy, Ecology, and USEPA 2000, Table 7-8), and COCs in groundwater at the point where groundwater enters the marine environment were arsenic and mercury (see also Section 3.2).

To achieve the RAOs, the remedial action components selected in the OU 1 ROD include the following:

- A vegetated cover consisting of a minimum 1-foot-thick soil cover plus sufficient topsoil to support vegetation was to be installed over the identified areas where COCs in surface soils exceeded the RGs.

- Shoreline stabilization measures were to be installed along the shoreline to limit erosion of soils that may contain COCs.

- Regular inspection and maintenance of the shoreline stabilization measures and soil covers were to be conducted and documented. Inspections were also to occur after major storm events. Physical maintenance was to be provided as needed.

- Permanent restrictions were to be placed on the property by the Navy to limit or prevent activities that may disturb the former construction debris landfill, the engineered soil cover over the debris in the Root Court cul-de-sac, or the petroleum-impacted soil in the vicinity of the playground. The Navy will be able to conduct digging and construction activities (e.g., building construction, utilities improvements, or maintenance) subject to restoring the integrity of the soil cover and taking necessary preventive measures to protect against short-term and long-term risks from contaminants.

- Permanent restrictions were to be placed on the property by the Navy to prevent construction of drinking water wells in the uppermost water-bearing unit. These restrictions apply to groundwater that is present in limited quantities above the Vashon Till.

4.2.2 Remedy Implementation

Remedy implementation occurred throughout OU 1, including Site 101-A, from June 2000 through June 2002. During this time, a soil cover was placed over the Root Court cul-de-sac area. Soil cover over this area was placed as described in Section 4.1.2, and a labeled indicator layer was placed under the clean material, also as described in 4.1.2.

Shoreline stabilization work along the beach area of Site 101-A occurred in the summer of 2000. Work consisted of removing miscellaneous debris along the shoreline, placing shellfish harvest restriction signs, and installing a low rock shelf at the toe of the slope.

4.2.3 Operation, Maintenance, and Monitoring

The operation, maintenance, and monitoring program for Site 101-A specified by the ROD consists of fulfilling ROD-mandated monitoring requirements, managing the institutional controls program, and maintaining the remedies implemented for the site.

Monitoring

LTM of seeps and outfalls at Site 101-A has been conducted since 2002, with semiannual sampling occurring the first year of sampling and annual sampling occurring thereafter, in accordance with the ROD. Sampling occurred in summer and fall of the first year and in summer of the following years. An additional sampling round was conducted in the fall of 2004 during an extreme low tidal cycle. Sampling of one seep (SP-715) and one outfall (OF-716) is included in the monitoring program at Site 101-A, and samples from these locations were analyzed as follows:

- All samples were analyzed for total metals (arsenic, beryllium, mercury, and thallium), dissolved metals (copper, lead, nickel, silver, and zinc), and cyanide.
- SP-715 was analyzed for GRO and DRO.
- OF-716 was analyzed for pesticides (chlordane).

All Site 101-A monitoring activities since the last 5-year review were performed in accordance with the LTM work plan (U.S. Navy 2002b). Five rounds of seep and outfall samples have been collected since the last 5-year review. The current sampling schedule is shown in Table 4-1. LTM locations are shown on Figure 4-1. The results of seep and outfall monitoring at Site 101-A are discussed in Section 6.4.

Marine tissue monitoring has also been conducted since 2002 as part of the LTM program for Site 101-A. Marine tissue monitoring for Sites 101, 101-A, and 103 is discussed in Section 4.1.3 and is not repeated here.

Institutional Controls

COCs in the groundwater beneath Site 101-A are required to meet ROD RGs at the point where groundwater enters the marine environment (point of compliance). To this end, the Land Use Control Plan (U.S. Navy 2005a) specifies permanent restrictions to be placed on use of shallow groundwater (above the Vashon Till) as a drinking water source.

In addition, the construction debris landfill and the areas of petroleum-impacted subsurface soil in the vicinity of Root Court are areas where land use restrictions will be required (i.e., controls on excavation and construction), and these areas are incorporated into the Land Use Control Plan (U.S. Navy 2005a). Figure 4-3 shows the areas of Site 101-A that require land use restrictions. Compliance inspections of the areas shown on Figure 4-3 have been implemented as part of the Land Use Control Plan to ensure that these areas remain undisturbed and that the soil cap continues to function as planned.

Remedy Maintenance

Remedy maintenance inspections for Site 101-A commenced in the spring of 2004 in accordance with the ROD and are described in Section 4.1.3.

4.3 SITE 103

4.3.1 Remedy Selection

The COCs in soil at Site 103 were cPAHs, arsenic, and PCBs (U.S. Navy, Ecology, and USEPA 2000, Table 7-9), and COCs in groundwater at the point where groundwater enters the marine environment were arsenic, mercury, silver, 1,1-DCE, TCE, and vinyl chloride (see also Section 3.3).

To achieve the RAOs, the remedial action components selected in the OU 1 ROD include the following:

- A vegetated cover consisting of a minimum 1-foot-thick soil cover plus sufficient topsoil to support vegetation was to be installed over the identified areas where COCs in surface soils exceeded the RGs.
- Shoreline stabilization measures were to be installed along the shoreline to limit erosion of soils that may contain COCs. The intent of the remedial design was to provide no net loss of productive fish and shellfish habitat.
- Permanent restrictions were to be placed on the property by the Navy to limit or prevent activities that may disturb the former ordnance burn area at Site 103.
- Regular inspection and maintenance of the shoreline stabilization measures and soil covers were to be conducted and documented. The inspections were also to occur after major storm events. Physical maintenance was to be provided as needed.
- For the portions of Site 103 where residential soil cleanup levels were exceeded, land use restrictions were to be put in place to prevent use of the site for residential occupancy.
- Permanent restrictions were to be placed on the property by the Navy to prevent construction of drinking water wells in the uppermost water-bearing unit. These

restrictions apply to groundwater that is present in limited quantities above the Vashon Till.

- For the designated intertidal areas and adjacent shoreline owned by the Navy, land use restrictions were to be implemented to address procedures for controlling construction and maintenance activities to prevent activities that may interfere with or compromise the function of the shoreline stabilization system. These restrictions were to include requirements for ongoing monitoring and maintenance of the shoreline stabilization system.

- A shellfish sampling program was to be implemented. The Navy, with concurrence from EPA, Ecology, and the Washington State Department of Health will decide when shellfish on JPHC/NHB beaches can be harvested and the purpose of those harvests, e.g., subsistence, recreational, commercial, or ceremonial gathering.

- Signs were to be posted along the shoreline to notify the JPHC residents (and any members of the general public) of any harvest restrictions.

- An investigation (including a geophysical survey) was to be conducted at Site 103 to attempt to identify the source of three VOCs, 1,1-DCE, TCE, and vinyl chloride, that exceeded RGs in seeps and outfalls along the north shoreline of Elwood Point. The Navy was to conduct an investigation to attempt to define a source of VOCs that may exist inland of the seeps and outfalls.

- An environmental monitoring program was to be conducted to include sampling of intertidal seeps and outfalls

- Approximately 450 wooden pilings from abandoned Navy structures, including part of Pier 2 in Site 101, the fishing pier on Elwood Point and its associated wooden pilings, and mooring dolphins offshore of Sites 101 and 103, were to be removed from Ostrich Bay and properly disposed of off site.

4.3.2 Remedy Implementation

Remedy implementation for Site 103 occurred primarily during 2001, although the bulk of the shoreline stabilization activities were completed in the late summer and early fall of 2000. The soil-cover activities occurred during 2001. In the soil subgrade, a subsurface drainage system was installed. Where the ground was not covered with sports facilities, soil cover was placed as described in Section 4.1.2. For two areas of the site (shown on Figure 4-3), a labeled indicator

layer (described in 4.1.2) was placed under the clean material to identify the areas where remaining subsurface contamination is still present.

During the remedial activities for both the soil and the shoreline portions of the site, the remediation crew was on alert for anything that could possibly be a source of VOCs (e.g., piping or buried drums), particularly vinyl chloride. A geophysical survey was conducted in the northern portion of the site to identify potential buried sources of VOCs. However, the data were reviewed and proved to be inconclusive. During remediation of the northern portion of the site, drums of unknown material were located and sampled, but did not contain vinyl chloride. No other suspect material was found. Therefore, the source of the VOCs is still unknown (U.S. Navy 2002a).

Shoreline stabilization remedial actions occurred primarily during the summer of 2000. Stabilization activities consisted of the following:

- Removal of debris and construction of a pocket beach along the south side of Site 103
- Removal of debris and construction of a low rock shelf with vegetation at the top of the shelf (described in Sections 4.2.2) along 550 feet of shoreline
- Construction of a set of granite beach access stairs 100 feet north of the fishing pier abutment (fishing pier has been removed; see below)
- Armor rock revetment and vegetation along approximately 500 feet of shoreline at the northwest end of Site 103
- Placement of shellfish harvesting restriction signs at several locations

As part of the remedy for protection of shellfish, the creosote-treated pilings associated with the pier on Elwood Point, fender piles around Pier 2 in Site 101, and a string of moorage dolphins (offshore from Sites 101 and 103) were removed during the summer of 2001. Pier 2 and the abutment only of the fishing pier at Elwood Point remain. Pilings removed included the following:

- 114 creosote piles from the string of dolphins
- 152 creosote fender piles and associated horizontal timbers around Pier 2
- 184 creosote-treated wood pilings, pier decking, and a steel terminus from the pier at Elwood Point

During remedial activities, the locations of the remaining underwater stubs of the pilings were recorded. A subtidal marine evaluation report was prepared in 2002 as an appendix to the remedial action closure report for OU 1 (U.S. Navy 2002a).

4.3.3 Operation, Maintenance, and Monitoring

The operation, maintenance, and monitoring program for Site 103 specified by the ROD consists of fulfilling ROD-mandated monitoring requirements, managing the institutional controls program, and maintaining the remedies implemented for the site.

Monitoring

LTM of seeps and outfalls at Site 103 has been conducted since 2002, with semiannual sampling occurring the first year of sampling and annual sampling occurring thereafter, in accordance with the ROD. Sampling occurred in summer and fall of the first year, and in summer of the following years. An additional sampling round was conducted in the fall of 2004 during an extreme low tidal cycle. Two seeps (SP-707 and SP-704) and one outfall (OF-705) were selected at Site 103 for sampling. However, SP-704 could not be located, and a replacement seep (SP-703) was located after two rounds of sampling had already occurred. Therefore, sampling of SP-703 began in 2003. All samples from these locations were analyzed for chlorinated VOCs (1,1-DCE, TCE, and vinyl chloride), pesticides (chlordane), total metals (arsenic, beryllium, mercury, and thallium), dissolved metals (copper, lead, nickel, silver, and zinc) and cyanide, except the sample collected from SP-703 in 2003 was not analyzed for pesticides (chlordane) and the samples collected from OF-705 in 2006 and 2008 were not analyzed for chlorinated VOCs (1,1-DCE, TCE, and vinyl chloride). The chain-of-custody form indicated that the laboratory was requested to analyze the sample collected from SP-703 for pesticides in 2003. However, neither the 2003 LTM report nor the Naval Installation Restoration System Solution database contains pesticides data for this location and date. It appears that OF-705 was not analyzed for chlorinated VOCs because of a simple oversight. This oversight is most likely the result of the 2002 LTM plan not being revised to reflect changes to the monitoring program.

All Site 103 monitoring activities since the last 5-year review were performed in accordance with the LTM work plan (U.S. Navy 2002b), except as noted in the paragraph above and in the following discussion. As a result, five rounds of seep and outfall samples have been collected since the last 5-year review. However, samples were not collected from location SP-707 in 2007, 2008, and 2009 because of the high salinity of the seep water, indicating the seep water was not representative of site groundwater. The current sampling schedule is shown in Table 4-1. LTM locations are shown on Figure 4-1. The results of seep and outfall monitoring at Site 103 are discussed in Section 6.4.

Marine tissue monitoring has also been conducted since 2002 as part of the LTM program for Site 103. Marine tissue monitoring for Sites 101, 101-A, and 103 is discussed in Section 4.1.3, and is not repeated here.

Institutional Controls

COCs in the groundwater beneath Site 103 are required to meet ROD RGs at the point where groundwater enters the marine environment (point of compliance). To this end, the Land Use Control Plan specifies permanent restrictions to be placed on use of shallow groundwater (above the Vashon Till) as a drinking water source.

The two areas of Site 103 where impacted soils are covered by a geotextile liner are areas where institutional controls regarding excavation and construction are required (Figure 4-3). In addition, residential development is not allowed on the site. Such controls are incorporated into the Land Use Control Plan (U.S. Navy 2005a). Compliance inspections of the areas shown on Figure 4-3 have been implemented as part of the Land Use Control Plan to ensure that these restrictions continue to function as planned.

Remedy Maintenance

Remedy maintenance inspections for Site 103 commenced in the spring of 2004 in accordance with the ROD and are described in Section 4.1.3.

4.4 SITE 110

4.4.1 Remedy Selection

The COCs in soil at Site 110 were cPAHs and arsenic (U.S. Navy, Ecology, and USEPA 2000), and COCs in groundwater in the upland areas below the Vashon Till were arsenic, beryllium, manganese, nickel, and vanadium (see also Section 3.4).

To achieve the RAOs, the remedial action components selected in the OU 1 ROD include the following:

- Surface soil containing arsenic and cPAHs above the cleanup levels in residential backyard areas on the east side of Haven Road was to be excavated and properly disposed of. The affected backyard area(s) were to be excavated to a maximum 2-foot depth to remove the contaminated surface soil, backfilled with clean fill, and revegetated. The volume of soil requiring excavation was estimated at 2,600 cubic yards. The remedial design would include a sampling program to characterize the exact extent of soils exceeding the cleanup levels.

- Soil containing arsenic and cPAHs above cleanup levels remains beneath paved areas in front of bunkers 100 and 101. Land use restrictions and requirements were to address maintenance of the asphalt cover and procedures for controlling activities that involve digging or construction that could cause exposure to contaminants in soil.

- Permanent restrictions were to be placed on the property by the Navy to prevent construction of drinking water wells in the uppermost water-bearing unit. These restrictions apply to groundwater that is present in limited quantities above the Vashon Till in the eastern portion of the site closest to the shore.

- An environmental monitoring program was to be conducted to include sampling of four existing Site 110 monitoring wells located in the western half of the site and screened in groundwater located beneath the Vashon Till to reassess groundwater background concentrations. Permanent restrictions were to be placed on the property by the Navy to prevent construction of drinking water wells at Site 110 (groundwater present below the Vashon Till) unless the chemical data from the environmental monitoring program demonstrate that inorganics at Site 110 are not present above the cleanup levels.

4.4.2 Remedy Implementation

The soils impacted with cPAHs and arsenic east of two residential buildings along Haven Road were further investigated in June 2001 and March 2002. The additional sampling efforts identified areas where soils contained cPAHs above the RG. Excavation and disposal of the cPAH soil from the upper 2 feet occurred in June 2002. A buffer zone was established to protect existing trees, and no excavation occurred in the zone. Pipe debris assumed to contain asbestos, lead-wrapped wire, and railroad ties assumed to be creosote-treated were discovered, removed, and properly disposed of during excavation. After excavation, clean material was backfilled into the area and covered with sod.

4.4.3 Operation, Maintenance, and Monitoring

The operation, maintenance, and monitoring program for Site 110 specified by the ROD consists of fulfilling ROD-mandated monitoring requirements, managing the institutional controls program, and maintaining the remedies implemented for the site.

Monitoring

Two rounds of sampling were required in the ROD to be conducted at four existing monitoring wells (MW-11, MW-13, MW-14, and MW-15) to determine concentrations of total and

dissolved inorganics (see Figure 4-1). In addition, wells representative of background metals concentrations were to be selected and sampled (MW-40 and MW-41). The groundwater background study was completed in 2001 (U.S. Navy 2001), and post-ROD sampling on site occurred in 2002 and 2004 (U.S. Navy 2003c and 2005e). Well MW-11 could not be located and is considered lost. Therefore, three wells were sampled in 2002. Subsequent to 2002, MW-14 was damaged during construction activities in 2003. Although MW-14 was repaired in late fall, only two wells, MW-13 and MW-15, were sampled in 2004. Because no samples exceeded the site-specific background values or RGs, the first 5-year review recommended that monitoring upland groundwater at Site 110 outside the Benzene Release Area be discontinued. As a result, groundwater monitoring at Site 110 was discontinued.

Institutional Controls

Two areas under pavement in front of Buildings 100 and 101 contain arsenic in soil above the ROD RG. A third area on the east side of South Shore Road near its intersection with Root Court (near the boundary of Sites 101, 101-A, and 110) contains petroleum compounds above MTCA Method A cleanup levels. These three areas require controls to prevent uncontrolled excavation or construction, and the areas in front of the buildings also require maintenance of the existing asphalt cover (see Figure 4-3). Such controls were incorporated into the Land Use Control Plan (U.S. Navy 2005a). Compliance inspections of the areas shown on Figure 4-3 have been implemented as part of the Land Use Control Plan to ensure that these restrictions continue to function as planned.

Remedy Maintenance

Remedy maintenance inspections for Site 110 commenced in the spring of 2004 in accordance with the ROD and are described in Section 4.1.3.

4.5 BENZENE RELEASE AREA

4.5.1 Remedy Selection

The overall RAO for the Benzene Release Area (U.S. Navy, Ecology, and USEPA 2000) was to prevent impacts to ecological receptors in the marine environment and to protect human health by attaining compliance with water quality standards for marine surface water at the point of groundwater discharge. Benzene is the COC.

To achieve this objective, the remedial action components selected in the OU 1 ROD include the following:

- Oxygen-releasing chemicals were to be placed in the subsurface using one or more of the following methods: injection of a slurry, backfilling of boreholes or open pits, or placement in monitoring wells.
- Limited excavation and disposal of petroleum-contaminated soil would occur if significant petroleum contamination were to be found above the seasonal high-water table. The specific quantities and locations of any excavation were to be determined in the remedial design.
- An environmental monitoring program was to be conducted to verify effectiveness of the remedy.

4.5.2 Remedy Implementation

Field work for the selected remedial action components at the Benzene Release Area occurred in April and May 2001. Fifty-six Oxygen Release Compound (ORC®) injection locations (35 in the source area and 21 downgradient), four new monitoring wells, and one replacement monitoring well were installed during the field effort. Approximately 8,400 pounds of ORC® were placed in the source area, and 5,040 pounds were placed downgradient. No excavation of petroleum soils was conducted during this remedial action.

4.5.3 Operation, Maintenance, and Monitoring

The operation, maintenance and monitoring program for the Benzene Release Area specified by the ROD consists of fulfilling ROD-mandated monitoring requirements for the site. The selected remedy for the Benzene Release Area does not include any institutional controls. The institutional controls that are included in the selected remedy for groundwater for Sites 101 and 110 prevent construction of drinking water wells within the Benzene Release Area.

The ROD specified that, initially, sampling of groundwater, seeps, and outfalls should occur quarterly for 2 years to assess the effectiveness of ORC® injection. Initial monitoring occurred from August 2001 through May 2003 (U.S. Navy 2003a and 2003b). Routine monitoring was continued after the 2-year period at the point of compliance (the outfall and seeps at Site 101). The outfall/seep results for Site 101 are also part of the LTM for the Benzene Release Area (see Section 4.1.3). However, routine monitoring of groundwater wells was discontinued after the initial 2-year period, because the results of the monitoring indicated that the monitoring network in place at that time was not adequate to define the distribution of TPH-G or benzene, ethylbenzene, toluene, and total xylenes (BTEX) in the groundwater beneath the site.

Specifically, the source wells were screened in the perched groundwater (HC-2, HC-4, and HC-5), and the downgradient wells were screened in the deeper groundwater beneath the Vashon Till (MW-4, MW-880, MW-881, MW-882, and MW-883). Sampling locations at the Benzene Release Area are shown on Figure 4-4.

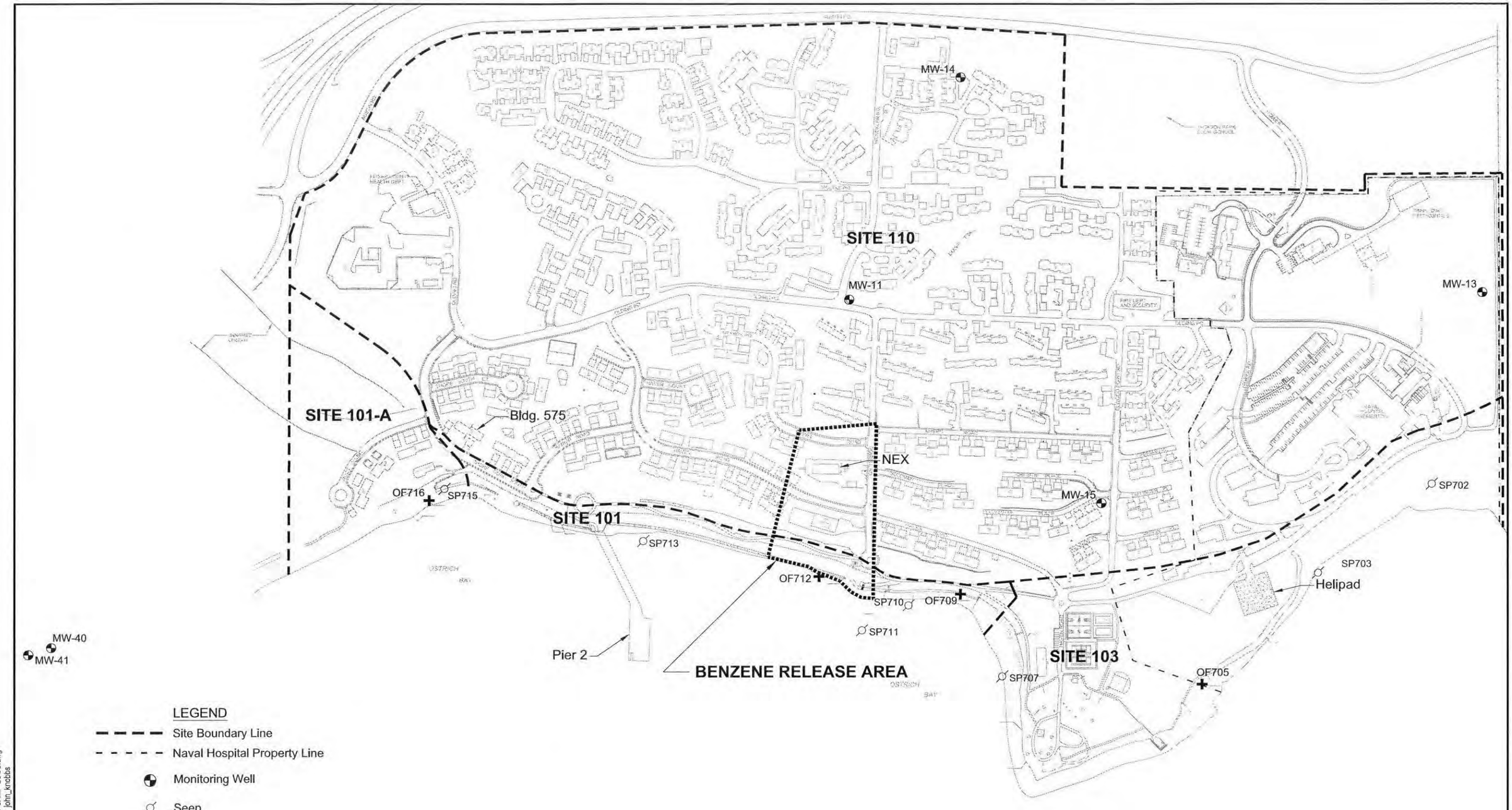
The 2 years of monitoring indicated that the ORC treatment appeared to be initially effective in the zone immediately adjacent to the ORC installation (U.S. Navy 2003a and 2003b). However, BTEX concentration trends noted at MW-4 suggested that a residual source of gasoline contamination was present at the site and that the contribution of dissolved petroleum constituents from the residual source and the site hydrogeology prevented the ORC treatment from achieving the cleanup objectives.

Based on these conclusions, additional site investigation and pilot testing were performed at the site during this 5-year review period including the following:

- A subsurface investigation performed in 2005 (U.S. Navy 2005d and 2006b)
- A dual-phase extraction (DPE) pilot test performed in 2006 (U.S. Navy 2006a and 2007b)
- Installation and operation of an active free-product skimming system (U.S. Navy 2007c, 2008c, and 2009f)

A summary of the investigations performed during this 5-year review period are included in Section 6.4.

An additional site investigation is planned for 2010 (U.S. Navy 2009b). The purpose of this investigation is to estimate the lateral extent of free product at the site, the vertical extent of dissolved-phase petroleum hydrocarbons in groundwater across the site, the concentrations of petroleum hydrocarbons discharging to Ostrich Bay, and the aquifer characteristics (transmissivity, hydraulic conductivity, and storativity) in the source area and near-shore area of the site. Furthermore, pilot testing of four remedial technologies (soil vapor extraction, bioventing, ORC, and air sparging) is planned as part of the field effort to evaluate their applicability to the site. The data collected during the field program will be incorporated, together with previously collected data, into a focused FS report for the site.



Notes:

1. Sampling locations based on 2002 survey data from CH2M HILL, when available (U.S. Navy 2002b). Remaining sampling locations based on 1996 RI/FS location data.
2. Sampling location SP704 could not be located and was replaced by SP703.
3. Well MW-11 could not be located in 2002, and is considered lost.

U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 200 400 SCALE IN FEET	**Figure 4-1 Long-Term Monitoring Seep and Outfall Sampling Locations**

T:\NAVY\jacks_pk\DI\DO 6402nd 5 Yr Review\FIG 4-1 SAMP LOCS.dwg
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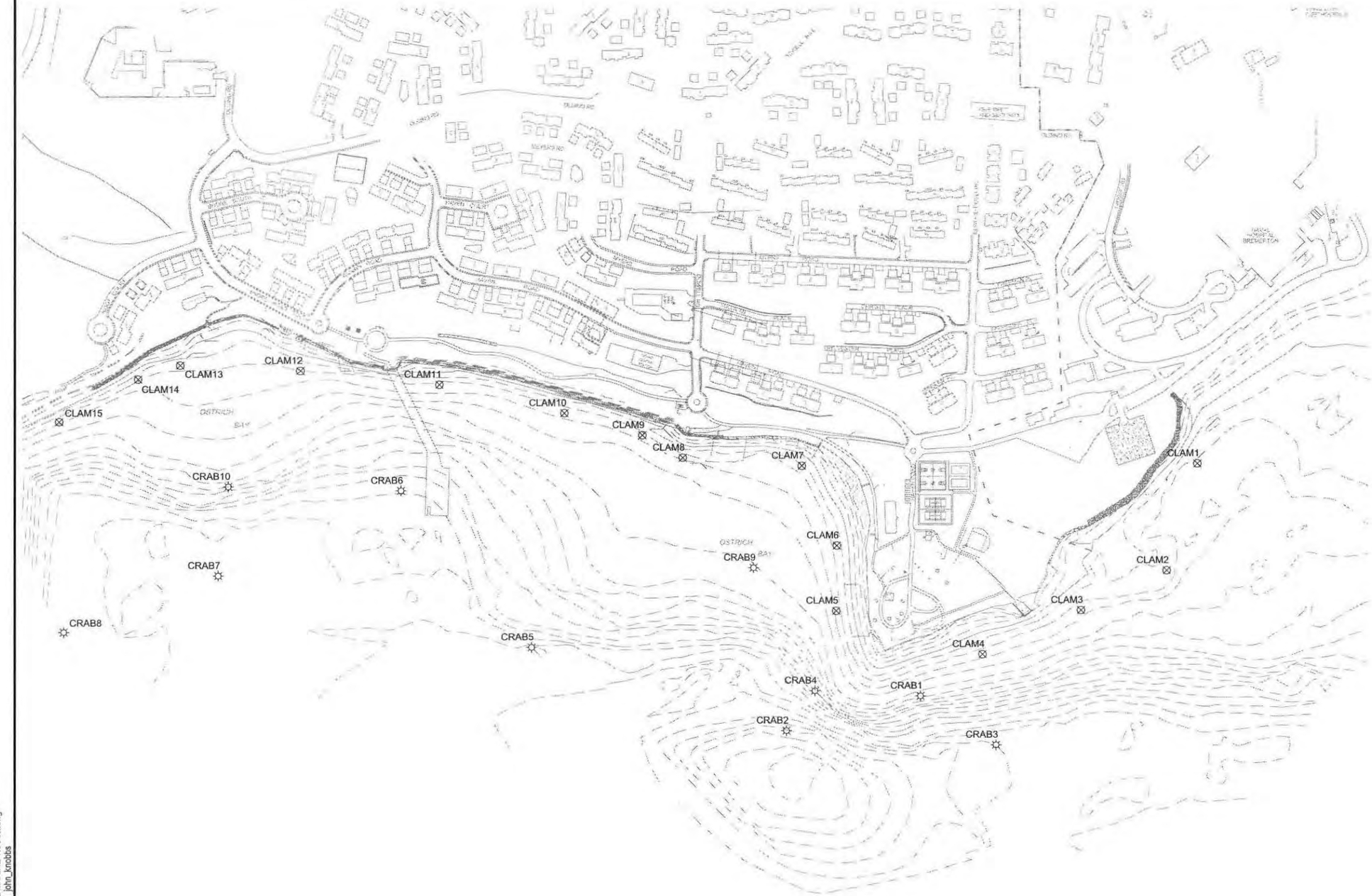

T:\NAVY\jacks_pkl\DIO\DO 64\2nd 5 Yr ReviewIFIG 4-2 MARINE TISSUE.dwg
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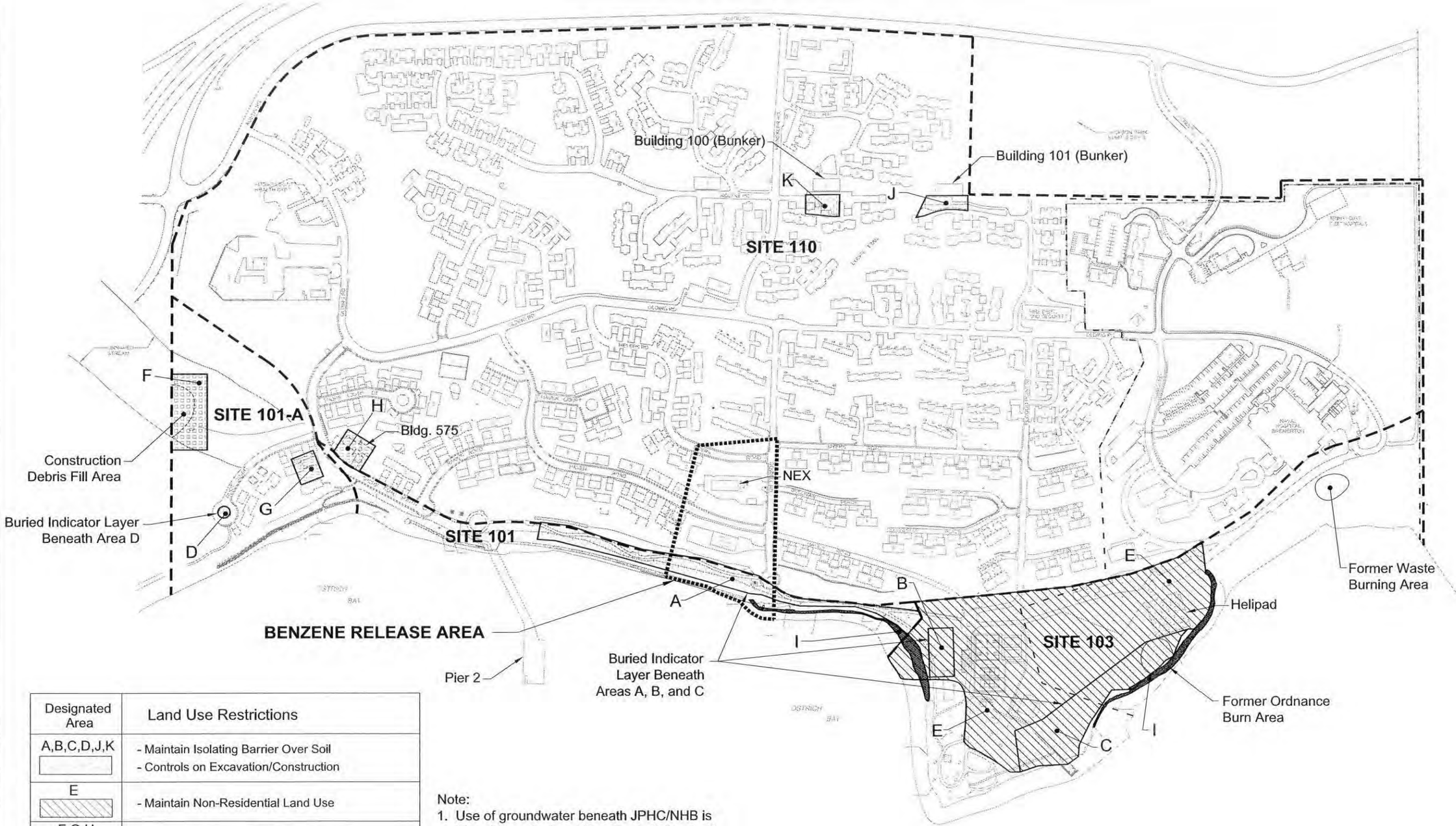
U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 200 400 SCALE IN FEET	**Figure 4-2** **Long-Term Monitoring Marine Tissue Sampling Locations**



Designated Area	Land Use Restrictions
A,B,C,D,J,K	- Maintain Isolating Barrier Over Soil - Controls on Excavation/Construction
E	- Maintain Non-Residential Land Use
F,G,H	- Controls on Excavation/Construction
I	- Maintain Shoreline Protection

Note:
1. Use of groundwater beneath JPHC/NHB is restricted (see the Land Use Control Plan text).

2. Signs must be maintained at beaches, notifying public of shellfish harvest restrictions.

LEGEND
- Site Boundary Line
- Naval Hospital Property Line

U.S. NAVY

JPHC/NHB
SECOND FIVE-YEAR
REVIEW

0 200 400
SCALE IN FEET

Figure 4-3
Land Use Restrictions

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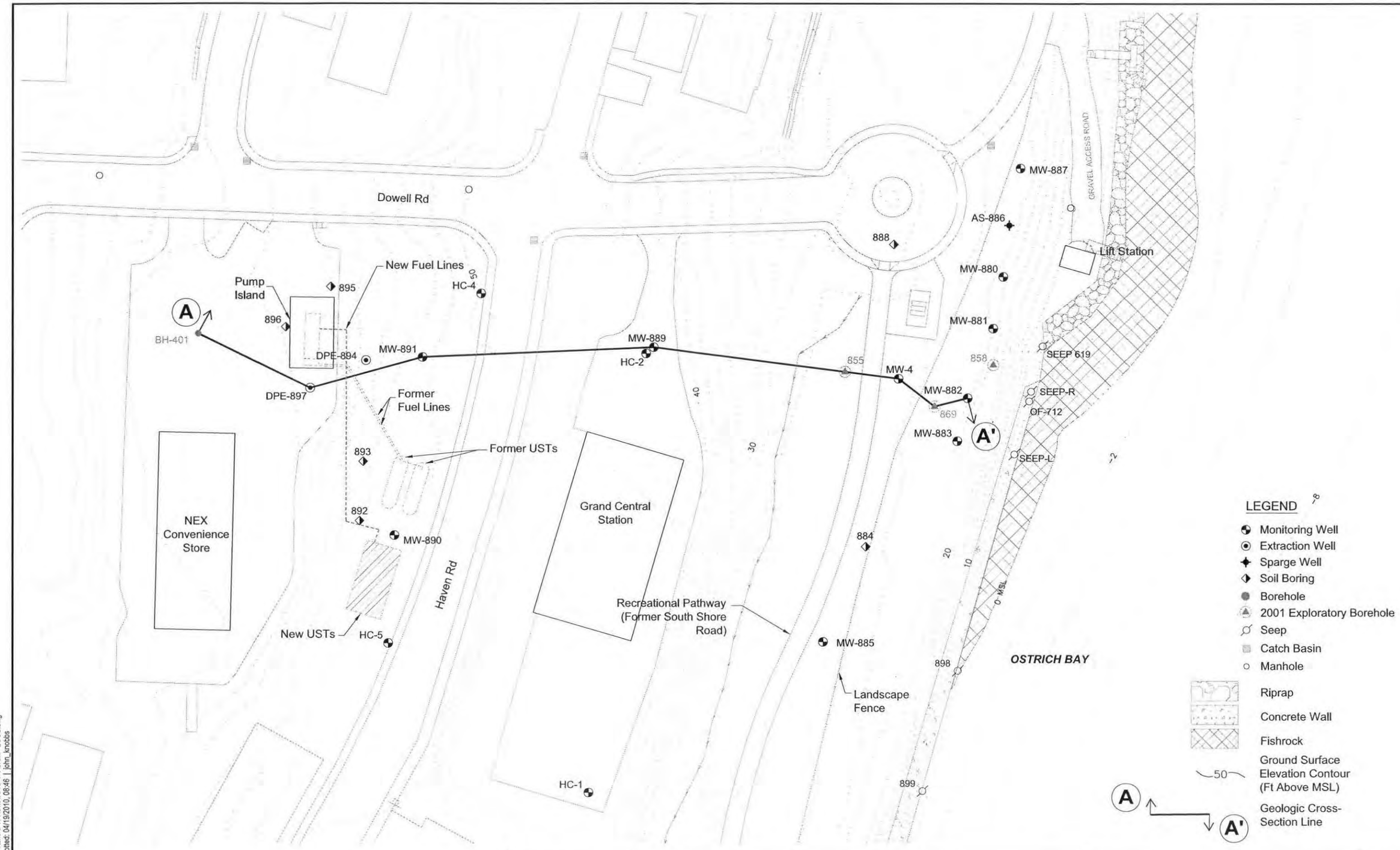

Notes:
1. Seep 619, Seep-L, and Seep-R are historical sampling locations which have not been sampled during this 5-year review period.

U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 25 50 SCALE IN FEET	**Figure 4-4 Sampling Locations at the Benzene Release Area**

T:\NAVY\jacks_pk\IDI\DO 64\2nd 5 Yr Review\FIG 4-4 SAMP LOCS.dwg
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Table 4-1
Sampling Locations, Frequencies, and Analytical Requirements for OU 1

Sampling Location	Sampling Frequency		Analyte								
	Annual	Once Every 5 Years	Chlorinated VOCs (1,1-DCE, TCE, Vinyl Chloride)	SVOCs[a]	Benzene	GRO and DRO	Pesticides (Chlordane)	Total and Dissolved Metals[b]	Total Metals[c]	Ordnance Compounds	Cyanide
Seeps and Outfalls											
SP-703	X		X				X	X			X
OF-705	X		X				X	X			X
SP-707	X		X				X	X			X
OF-709	X		X					X			X
SP-710	X				X	X		X			X
SP-711	X				X	X		X			X
OF-712	X				X			X			X
SP-713	X							X			X
SP-715	X					X		X			X
OF-716	X						X	X			X
Marine Tissue											
16 tissue sampling locations		X		X					X	X	
Background stations[d]		X							X	X	

[a]Samples will be tested for 3,3'-dichlorobenzidine and pentachlorophenol.
[b]Samples will be tested for total metals (arsenic, beryllium, mercury, and thallium) and dissolved metals (copper, lead, nickel, silver, and zinc).
[c]Samples will be tested for antimony, arsenic, and vanadium.
[d]Up to three background stations will be sampled, depending on the species of crab found during the sampling event.

Table 4-1 (Continued)
Sampling Locations, Frequencies, and Analytical Requirements for OU 1

Notes:
DCE - dichloroethene
DRO - diesel-range organics
GRO - gasoline-range organics
OF - outfall
SP - seep
SVOCs - semivolatile organic compounds
TCE - trichloroethene
VOC - volatile organic compound

Table 4-2
OU 1 Inspection and Maintenance Program Master Schedule

Site	Remedial Measure	Inspection/Maintenance Activity	Frequency
All	All	Identify and report remedial measures requiring nonroutine maintenance.	As identified
All	All	Inspect structures, facilities, and utilities after severe weather events and initiate repair as needed.	Within 72 hours of weather event
101, 101-A, and 103	Trees and shrubs	Inspect trees and shrubs; prune as needed in early spring prior to start of growing season.	Annually
101, 101-A, 103, and 110	Roadways, floors, pads, sidewalks, etc.	Inspect surfaces for new cracks greater than 1/8 inch or changes to existing cracks.	Semiannually
101, 101-A, and 103	Gravel paths and unpaved trails	Maintain gravel paths and unpaved trails free of vegetation, erosion, washboarding, potholes, etc.	Semiannually
101, 101-A, and 103	Grassed areas, playground, and ball field	Inspect for settling, erosion, dead grass, holes, or excavation and maintain as appropriate.	Semiannually
101, 101-A, and 103	Low rock shelf	Inspect low rock shelf for erosion and settling of rock. Inspect rock for spalling and fracturing. Inspect stairways for erosion and settling around, below, or behind stair and supports.	Semiannually
101, 101-A, and 103	Shoreline vegetation	Inspect plantings for stressed or dead vegetation and replace as needed.	Semiannually
101, 101-A, and 103	Mulch beds	Inspect to ensure adequate mulch is in place and augment as needed.	Semiannually
101 and 103	Armor stone revetment	Inspect around, below, or behind stairways and rock shelf for erosion.	Semiannually
101	Seawall	Inspect seawall for erosion and failure of the concrete.	Semiannually
101	Storm drainage	Monitor for significant erosion or blockage.	Semiannually
101, 101-A, and 103	Low rock shelf	Inspect low rock shelf for rocks removed and potentially thrown onto beach/intertidal area and replace as needed.	Quarterly
101, 101-A, and 103	Shellfish harvest restriction signs	Inspect signs and repair or replace as needed.	Quarterly
101, 101-A, and 103	Shoreline vegetation	Inspect plantings, beds, bulkheads, retaining walls, and riprap areas for weeds and remove.	Quarterly
101, 101-A, and 103	Shoreline vegetation	Inspect beds and plantings to establish whether watering is needed.	Quarterly
101 and 103	Armor stone revetment	Inspect armor stone revetment for rocks removed and potentially thrown onto beach/intertidal area and replace as needed.	Quarterly
101 and 103	Pocket beach	Monitor for beach erosion.	Quarterly
101, 101-A, and 103	Shoreline vegetation	Water newly planted vegetation.	Weekly in summer 2008, and as needed in 2009

5.0 PROGRESS SINCE LAST FIVE-YEAR REVIEW

This section summarizes the status of recommendations and follow-up actions from the last review, the results of implemented actions, including whether they achieved the intended purpose, and the status of any other prior issues (Table 5-1). The Navy has continued the monitoring actions recommended by the last 5-year review, executed by the Navy October 27, 2005. The development of a regional land use control instruction covering JPHC/NHB is still pending.

Table 5-1
Summary of Progress Since Last 5-Year Review

Recommendation/Follow-up Action From First 5-Year Review (2005)	Completion Date	Notes Regarding Completion	Reference
Implement enhancements to the remedy for the Benzene Release Area based on the results of the upcoming additional investigations.[a]	Ongoing	EPA did not concur with this recommendation, and substantial additional investigation has been performed (and is ongoing) to address EPA's concerns (see also Section 4.5.3).	USEPA 2006 and U.S. Navy 2006b, 2007b, 2007c, 2008c, and 2009f
Implement the Land Use Control Plan being prepared concurrently with this 5-year review.	Ongoing	Compliance inspections of the institutional control areas shown on Figure 4-3 have been implemented as part of the Land Use Control Plan to ensure that these restrictions continue to function as planned.	U.S. Navy 2005a
Prepare institutional control base instructions.	Pending	Naval Base Kitsap (NBK) is in the process of drafting a Regional Land Use Control Instruction covering the Bremerton naval complex, Jackson Park Housing Complex, Naval Hospital Bremerton, NBK Bangor, NBK Keyport, and Naval Magazine Indian Island.	
Continue long-term monitoring at seeps and outfalls.	Ongoing	Long-term monitoring of seeps and outfalls has been conducted since 2002, with semiannual sampling occurring the first year of sampling and annual sampling occurring thereafter.	U.S. Navy 2003c, 2003d, 2004c, 2005e, 2005f, 2005g, 2007a, 2008d, 2009c, and 2009d

Table 5-1 (Continued)
Summary of Progress Since Last 5-Year Review

Recommendation/Follow-up Action From First 5-Year Review (2005)	Completion Date	Notes Regarding Completion	Reference
Continue shellfish monitoring with a revised analyte list and a reduced sampling frequency—once prior to each 5-year review.[a]	Ongoing	Shellfish monitoring and evaluation of risks to human health were performed in 2009 prior to this 5-year review.	U.S. Navy 2009e
Discontinue use restrictions and monitoring for upland groundwater at Site 110.	May 11, 2006	EPA's letter indicated concurrence with this recommendation.	USEPA 2006

[a]EPA's letter of May 11, 2006 included additional recommendations that EPA stated would be tracked by EPA instead of the first and fifth Navy recommendations listed in Table 5-1.

Note: EPA – U.S. Environmental Protection Agency

6.0 FIVE-YEAR REVIEW PROCESS

6.1 FIVE-YEAR REVIEW TEAM

The Navy is the lead agency for this 5-year review. Personnel from NAVFAC NW, NBK, and NHB represented the Navy in this 5-year review. Project managers and other staff from EPA and Ecology have also participated in the review process. Both the EPA and Ecology are cosignatories of the ROD for JPHC/NHB. All team members had the opportunity to provide input to this report.

6.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

There are specific requirements pursuant to CERCLA Section 117(a), as amended, that require certain reports to be released to the public and that the public be notified of proposed cleanup plans and remedial actions. The community notification and involvement activities are described below.

The Navy placed a notice in the *Kitsap Sun* on November 8, 2009, informing the public that the site is currently undergoing a 5-year review. This notice also provided information as to when, where, and how the public could receive information and how to provide comments on the protectiveness of the remedy. There has been no public response resulting from the notice. In addition to the notice, selected community members (primarily Restoration Advisory Board [RAB] members) were interviewed as part of the site interview process described in Section 6.6.

Historically, community relations activities have established communication between the citizens living near the site, other interested organizations, the Navy, EPA, and Ecology. The actions taken to satisfy the statutory requirements also provided a forum for citizen involvement and input to the Proposed Plan and the ROD. These actions included the creation of a community relations plan and periodic meetings between the public and the agencies in the form of RAB meetings. RAB meetings have occurred periodically beginning in 1995.

The purpose of the RAB is to act as a forum for the discussion and exchange of information among the Navy, regulatory agencies, and the community on environmental restoration topics. RAB meetings provide an opportunity for the stakeholders to review progress and participate in the decision-making process by reviewing and commenting on actions and proposed actions involving releases or threatened release at the installation.

The Proposed Plan for JPHC/NHB OU 1 was issued in October 1999 and mailed to all residences at JPHC and other members of the public. An open house and public meeting were held on October 20, 1999. The public comment period expired on November 4, 1999, and a response to public comments was included in the ROD (the Responsiveness Summary).

6.3 DOCUMENT REVIEW

Documents reviewed during this 5-year review of the ROD for OU 1 were those documents describing the monitoring, inspection, and maintenance of the selected remedies. The documents that were reviewed are listed below:

- The signed ROD (U.S. Navy, Ecology, and USEPA 2000)
- The first 5-year review report (U.S. Navy 2005c)
- The LTM work plan (U.S. Navy 2002b)
- The inspection and maintenance plans (U.S. Navy 2003e and 2008b)
- The Benzene Release Area work plans (U.S. Navy 2005d and 2006a)
- The long-term monitoring reports (groundwater, shellfish, seep, and outfall monitoring) (U.S. Navy 2003c, 2003d, 2004c, 2005e, 2005f, 2005g, 2007a, 2008d, 2009c, 2009d and 2009e)
- The inspection reports (U.S. Navy 2004b, 2005h, 2005i, 2005j, 2006c, 2007d, 2008e, 2009g, 2009h, and 2009i)
- The Benzene Release Area investigation reports (U.S. Navy 2006b and 2007b)
- The engineering evaluation/cost analysis report for the Benzene Release Area (U.S. Navy 2007c)
- The action memorandum for non-TCRA of light nonaqueous-phase liquid (LNAPL) at the Benzene Release Area (U.S. Navy 2008c)
- The free-product removal system operation and maintenance manual (U.S. Navy 2009f)

- Preliminary results for free-product removal system (Thelin 2009a and 2009b)
- The underground storage tank site assessment report (U.S. Navy 2008f)

6.4 DATA REVIEW

LTM of seeps, outfalls, and shellfish was required under the OU 1 ROD and has been occurring since the completion of the remedial actions. The ROD specified that at least 10 seeps and outfalls be sampled as part of LTM for the combined shore areas (Sites 101, 101-A, and 103). The ten locations were apportioned as follows: five seep and outfall locations in Site 101, two locations in Site 101-A, and three locations in Site 103. Monitoring began in late June 2002 and has continued to the present. The monitoring results for each of the sites are discussed below. Results from the shellfish sampling are not discussed separately for each site. Shellfish sampling results are discussed together, because the samples were collected in the bay offshore from three shore area sites, Sites 101, 101-A, and 103. In addition to the LTM activities, remedy inspection and maintenance activities have been conducted since the spring of 2004 as required by the ROD. These inspection and maintenance activities are discussed together for all sites in Section 6.4.7.

Two rounds of groundwater sampling at Site 110 were also required in the ROD, and wells representative of background metals concentrations were sampled as a one-time event. The groundwater background study was completed in 2001 and post-ROD sampling at Site 110 occurred in 2002 and 2004. Because no samples exceeded the site-specific background values or RGs, the first 5-year review recommended that monitoring upland groundwater at Site 110 outside the Benzene Release Area be discontinued. As a result, groundwater monitoring at Site 110 was discontinued, and no groundwater sample was collected at Site 110 outside the Benzene Release Area during this 5-year review period. However, two tank removals were performed at NHB in 2008, and as part of the tank removals, groundwater samples were collected. The tank removal is summarized in Section 6.4.5.

The ROD specified that sampling of groundwater, seeps, and outfalls should occur quarterly for 2 years to assess the effectiveness of ORC injection at the Benzene Release Area. Initial monitoring occurred from August 2001 through May 2003. Routine monitoring was continued after the 2-year period at the point of compliance (the outfall and seeps at Site 101). However, routine monitoring of groundwater wells was discontinued after the initial 2-year period, because the results of the monitoring indicated that the monitoring network in place at that time was not adequate to define the distribution of TPH-G or BTEX in the groundwater beneath the site. Furthermore, BTEX concentration trends suggested that a residual source of gasoline contamination was present at the site and that the contribution of dissolved petroleum constituents from the residual source and the site hydrogeology prevented the ORC treatment

from achieving the cleanup objectives. Based on these conclusions, additional site investigation and pilot testing were performed at the site during this 5-year review period. The results of the additional site investigations at the Benzene Release Area are summarized in Section 6.4.6.

Sections 6.4.1 through 6.4.7 present the review of data generated since the last 5-year review, through July 2009. The data review is presented by site. The analytical data are summarized in Tables 6-1 through 6-9.

6.4.1 Seep and Outfall Sampling for Site 101

Three seeps (SP-710, SP-711, and SP-713) and two outfalls (OF-709 and OF-712) located at Site 101 have been sampled since the last 5-year review (Figure 4-1). Historical and recent seep and outfall monitoring data for chlorinated VOCs (DCE, TCE, and vinyl chloride), benzene, petroleum hydrocarbons (GRO, DRO, and residual-range organics [RRO]), and inorganics (total metals [arsenic, beryllium, mercury, and thallium], dissolved metals [copper, lead, nickel, silver, and zinc] and cyanide) at Site 101 are summarized in Tables 6-1, 6-2, 6-3, and 6-5, respectively. For location SP-711, the water sample salinity was too high for all but one of the sampling events that have occurred since the last 5-year review, indicating that the water was not representative of groundwater. Therefore, only four locations within Site 101 were sampled during five of the six sampling events. During this 5-year review period, three chemicals (benzene, mercury, and cyanide) were detected in seep water at least once above their respective RGs.

Benzene was detected at OF-712 above its RG during five of the six sampling events that have occurred since the last 5-year review and during 9 of the 10 sampling events that have occurred since monitoring began (see Table 6-2). There are no clear benzene concentration trends at this location. The highest detected concentrations occurred in summer 2002 and summer 2007, and the lowest detected concentration occurred in fall 2004. Note that OF-712 is downgradient of the Benzene Release Area, which is discussed in Section 6.4.6. Benzene was detected at SP-710 only once since monitoring began, during the summer 2009 sampling event. The detected concentration was well below the RG. Benzene was not detected in the three samples collected at SP-711.

Total mercury was detected at SP-711 above its RG (Note that mercury's RG was adjusted from the ROD level of 0.025 to 0.1 µg/L based on the practical quantitation limit [PQL] [U.S. Navy 2001]) during the fall 2002 and 2004 sampling events (see Table 6-5). Total beryllium was detected at SP-711 once in the fall of 2002 (before this review period) at a concentration above its RG. No other metals were detected above their respective RGs at SP-711 since monitoring began at the site. Total metals and dissolved metals at OF-709, OF-712, SP-710, and SP-713 were either not detected or were detected at concentrations lower than their RGs since the last 5-year review. However, total beryllium exceeded its RG at SP-713 during the summer 2002

sampling event, and the total mercury detection limit exceeded the RG at all locations during the summer 2002, fall 2002, summer 2003, and summer 2009 sampling events and at location OF-712 during the summer 2005 sampling event. Dissolved beryllium has not exceeded its RGs since 2002.

Cyanide was detected at OF-709, OF-712, SP-710, and SP-713 above its RG during the summer 2005 sampling event (see Table 6-5). During all other sampling events, cyanide was not detected in any of the samples. However, the detection limit was consistently above the RG. The OU 1 ROD established the cyanide RG based on the marine water quality criterion, which is below the PQL. The ROD did not establish the cyanide RG as the PQL. Therefore, the absence of cyanide above its RG during these other sampling events cannot be verified.

None of the other chemicals being monitored at Site 101 were detected above their RGs. Chlorinated VOCs have not been detected at OF-709 during any of the sampling events (see Table 6-1). GRO has not been detected at SP-710 and SP-711 during any of the sampling events where data are available (see Table 6-3). DRO was detected at SP-710 during 2 of the 6 sampling events that have occurred since the last 5-year review and during 3 of the 10 sampling events that have occurred since monitoring began. DRO was detected at SP-711 during one of the three sampling events that has occurred since monitoring began. RRO was detected at SP-710 during 3 of the 6 sampling events that have occurred since the last 5-year review and during 3 of the 10 sampling events that have occurred since monitoring began. RRO was detected at SP-711 during all three sampling events that have occurred since monitoring began. There is no RG for DRO or RRO.

Based on these sampling results, the following reductions in the monitoring program are recommended:

- Monitoring for chlorinated VOCs at OF-709 should be discontinued, because chlorinated VOCs have not been detected since monitoring began in 2002.
- Monitoring for total metals and dissolved metals at OF-709, SP-710, OF-712, and SP-713 should be discontinued, because they were either not detected or detected at concentrations lower than their RGs during sampling events conducted since the last 5-year review.

Although benzene has not been detected at SP-710 and SP-711 and GRO, DRO, and RRO have either been not detected or detected at low concentrations at these locations, monitoring should continue because of the proximity of the Benzene Release Area and the potential for future impacts.

6.4.2 Seep and Outfall Sampling for Site 101-A

One seep (SP-715) and one outfall (OF-716) located at Site 101-A have been sampled since the last 5-year review (Figure 4-1). Historical and recent seep and outfall monitoring data for petroleum hydrocarbons (GRO, DRO, and RRO), pesticides (chlordane), and inorganics (total metals [arsenic, beryllium, mercury, and thallium], dissolved metals [copper, lead, nickel, silver, and zinc] and cyanide) at Site 101-A are summarized in Tables 6-3, 6-4, and 6-5, respectively. Both locations at Site 101-A were sampled during all six sampling events that have occurred since the last 5-year review. During this 5-year review period only cyanide was detected above its RG.

Metals have not been detected above their respective RGs at SP-715 since monitoring began at the site. Total metals and dissolved metals at OF-716 were either not detected or detected at concentrations lower than their RGs since monitoring began at the site. However, the total mercury detection limit exceeded the RG at all locations during the summer 2002, fall 2002, summer 2003, and summer 2009 sampling events.

Cyanide was detected at SP-715 above its RG during the summer 2005 and the summer 2007 sampling events (see Table 6-5), and it was detected at OF-716 above its RG during the summer 2005, summer 2006, summer 2007, and the summer 2008 sampling events. All other analytical results for cyanide were nondetects. However, the detection limit was consistently above the RG. The OU 1 ROD established the cyanide RG based on the marine water quality criterion, which is below the PQL. The ROD did not establish the cyanide RG as the PQL. Therefore, the absence of cyanide above its RG in these samples cannot be verified.

None of the other chemicals being monitored at Site 101-A were detected above their RGs. GRO was detected at SP-715 during 2 of the 6 sampling events that have occurred since the last 5-year review and during 3 of the 10 sampling events that have occurred since monitoring began (see Table 6-3). None of the detected concentrations exceeded the RG for GRO. DRO was detected at SP-715 during 2 of the 6 sampling events that have occurred since the last 5-year review and during 2 of the 10 sampling events that have occurred since monitoring began. RRO was detected at SP-715 during 1 of the 6 sampling events that have occurred since the last 5-year review and during 1 of the 10 sampling events that have occurred since monitoring began. There is no RG for DRO or RRO. Chlordane has not been detected at OF-716 during any of the sampling events (see Table 6-4). However, the detection limit was consistently above the RG during the last 5-year review period and during two sampling events during this 5-year review period (fall 2004 and summer 2007).

Based on these sampling results, the following reductions in the monitoring program are recommended:

- Monitoring for total metals and dissolved metals at SP-715 and OF-716 should be discontinued, because metals at these locations have not been detected above RGs since monitoring began in 2002.
- Monitoring for petroleum hydrocarbons at SP-715 should be discontinued, because they were either not detected, detected at low concentrations (DRO and RRO do not have RGs), or detected at concentrations lower than their RGs (GRO).
- Monitoring for chlordane at OF-716 should be discontinued, because it was not detected during any of the sampling events conducted since monitoring began in 2002. Although the detection limit exceeded the RG during 6 of the sampling events, the detection limit exceeded the RG only once in the last 5 years.

6.4.3 Seep and Outfall Sampling for Site 103

Two seeps (SP-707 and SP-703) and one outfall (OF-705) located at Site 103 have been sampled since the last 5-year review (Figure 4-1). Historical and recent seep and outfall monitoring data for chlorinated VOCs (1,1-DCE, TCE, and vinyl chloride), pesticides (chlordane), and inorganics (total metals [arsenic, beryllium, mercury, and thallium], dissolved metals [copper, lead, nickel, silver, and zinc] and cyanide) at Site 103 are summarized in Tables 6-1, 6-4, and 6-5, respectively. At location SP-707, the water sample salinity was too high in 2007, 2008, and 2009, indicating that the water was not representative of groundwater. Therefore, this location was not sampled during those three years. SP-703 and OF-705 were sampled during all six sampling events that have occurred since the last 5-year review. However, the sample collected from SP-703 in 2003 was not analyzed for pesticides (chlordane), and the samples collected from OF-705 in 2006 and 2008 were not analyzed for chlorinated VOCs (1,1-DCE, TCE, and vinyl chloride). During this 5-year review period, three chemicals (copper, nickel, and cyanide) were detected at least once above their respective RGs.

Dissolved nickel was detected at OF-705 above its RG during the summer 2008 sampling event (see Table 6-5). No other metals were detected above their respective RGs at OF-705 since monitoring began at the site. Total metals and dissolved metals at SP-703 were either not detected or detected at concentrations lower than their RGs since monitoring began at the site. Total and dissolved metals at SP-707 were either not detected or detected at concentrations lower than their RGs since the last 5-year review. However, total arsenic exceeded its RG at SP-707 during the summer 2003 sampling event, total beryllium exceeded its RG at SP-707 during the fall 2002 and summer 2003 sampling events, and total mercury exceeded its RG at SP-707

during the fall 2002 sampling event. Furthermore, the total mercury detection limit exceeded the RG at SP-703 during the summer 2003 and summer 2009 sampling events; at OF-705 during the summer 2002, fall 2002, summer 2003, and summer 2009 sampling events; and at location SP-707 during the summer 2002, summer 2003, and summer 2005 sampling events. Total arsenic and total beryllium have not been detected above their RGs at SP-707 since 2003, and total mercury has not been detected above its RG at that same location since fall 2002, although detection limits exceeded the RG in 2003 and 2005.

Cyanide was detected at all three locations above its RG during the summer 2005 sampling event (see Table 6-5), and it was detected at OF-705 above its RG during the summer 2002 sampling event. All other analytical results for cyanide were nondetects. However, the detection limit was consistently above the RG. The OU 1 ROD established the cyanide RG based on the marine water quality criterion, which is below the PQL. The ROD did not establish the cyanide RG as the PQL. Therefore, the absence of cyanide above its RG in these samples cannot be verified.

None of the other chemicals being monitored at Site 103 were detected above their RGs. Chlorinated VOCs have not been detected at SP-707 during any of the sampling events (see Table 6-1). 1,1-DCE and vinyl chloride have not been detected at SP-703 during any of the sampling events. TCE was detected at this location during all sampling events at low concentrations. 1,1-DCE has not been detected at OF-705 during any of the sampling events. Vinyl chloride was detected at this location during 2 of the 7 sampling events that have occurred since monitoring began, and TCE has been detected during all sampling events. None of the detected concentrations of chlorinated VOCs exceeded their RGs. Chlordane has not been detected at SP-703 and SP-707 during any of the sampling events (see Table 6-4). Chlordane was detected once at OF-705 during the summer 2007 sampling event at a concentration less than the RG. However, the detection limit was consistently above the RG during the last 5-year review period and during two sampling events during this 5-year review period (fall 2004 and summer 2007).

Based on these sampling results, the following reductions in the monitoring program are recommended:

- Monitoring for total metals and dissolved metals at SP-703 should be discontinued, because metals at this location have not been detected above RGs since monitoring began in 2002.

- Monitoring for chlorinated VOCs at SP-703 and SP-707 should be discontinued, because they were either not detected or detected at concentrations lower than their RGs since monitoring began in 2002. Monitoring at OF-705 should continue, because detected concentrations of TCE are close to the RG, and there is no clear concentration trend.

- Monitoring for chlordane at OF-705, SP-703, and SP-707 should be discontinued because it was detected only one time at OF-705 since monitoring began in 2002, and it was detected at a concentration less than the RG. Although the detection limit consistently exceeded the RG until fall 2004, it exceeded the RG only once in the last 5 years.

6.4.4 Shellfish Sampling

During the 2009 sampling event, clam tissues were collected from 15 intertidal stations and crab tissues samples from 10 subtidal stations along the JPHC/NHB beach bordering Ostrich Bay (see Figure 4-2). Clam tissues were also collected from three intertidal background stations at Twanoh State Park on Hood Canal, and crab tissues were collected from four subtidal background stations along the Gilberton/Brownsville shoreline. Historical and recent shellfish monitoring data for total metals (antimony, arsenic, and vanadium), SVOCs (3,3′-dichlorobenzidine and pentachlorophenol), and ordnance compounds are summarized in Tables 6-6, 6-7, and 6-8, respectively. In addition, the 2009 tissue samples were analyzed for arsenic speciation, including total, organic, inorganic, pentavalent, and trivalent arsenic (see Table 6-9).

Antimony and vanadium were either not detected, or detected at background concentrations prior to the 2009 monitoring event (Table 6-6). Antimony and vanadium were not detected in any clam or crab tissue samples collected in 2009. Total arsenic was detected in all clam and crab tissue samples in 2002, 2004, and 2009. The average arsenic concentration detected in clams was 20.6 mg/kg dry weight in 2002, 23.7 mg/kg dry weight in 2004, and 19.0 mg/kg dry weight in 2009. The average arsenic concentration detected in crabs was 45.1 mg/kg dry weight in 2002, 40.3 mg/kg dry weight in 2004, and 49 mg/kg dry weight in 2009. No clear concentration trends are apparent for arsenic based on these data. Arsenic speciation was performed during the 2009 LTM sampling event in an effort to determine the proportions of organic and inorganic arsenic in crab and clam tissue. The majority of the total arsenic detected in the clam and crab tissue was in the form of organic arsenic, with percentages in the range of 98.3 to 99.6 percent in clams and 99.6 to 100 percent in crabs (Table 6-9).

No pentachlorophenol or 3,3′-dichlorobenzidine has been detected in shellfish tissue in the 2002, 2004, and 2009 LTM sampling events (Table 6-7).

Ordnance compounds have been infrequently detected in shellfish tissue and only three ordnance compounds—1,3,5-trinitrobenzene, 4-amino-2,6-dinitrotoluene, royal demolition explosive (RDX)—were detected at very low levels in 2002 and 2004. All of these historical detections were qualified as "estimated" by the analytical laboratory. In 2009, three ordnance compounds were presumptively detected in clam tissue, but no ordnance compound was detected in the crab tissue samples from OU 1. However, one ordnance compound, tetryl, was detected in one crab

tissue sample collected at the Gilberton/Brownsville shoreline background site. 2,4-Dinitrotoluene was presumptively detected at very low levels in clam tissue from three stations and 2,6-dinitrotoluene was presumptively detected at very low levels in clam tissue from two stations at JPHC/NHB in 2009. The only ordnance compound that was detected in more than one year, RDX, was not detected at the same sampling location.

Because of interferences with the analytical method employed to quantify the ordnance compounds in tissue, and because the detections were very close to the laboratory MDL, definitive presence of these compounds could not be confirmed or refuted. One additional compound, 1,3,5-trinitrobenzene, was also presumptively detected in clam tissue collected from two stations in 2009, but the presence of this compound was not confirmed with follow-up analysis of the tissue samples by a more definitive method.

The ROD did not establish numerical RGs for chemicals in shellfish tissue. Instead, the ROD states: "The shellfish sampling will terminate when human health risks associated with antimony, arsenic, vanadium, 3,3'-dichlorobenzidine, pentachlorophenol, and ordnance compounds in shellfish reach 1 x 10^{-5} excess cancer risk and hazard index of 1, or when the risks are reduced to a risk consistent with consumption of reference area shellfish." An evaluation of risks associated with antimony, arsenic, vanadium, 3,3'-dichlorobenzidine, pentachlorophenol, and ordnance compound concentrations in shellfish tissue is provided in Section 7.

6.4.5 Groundwater and Soil Sampling at Site 110

During this 5-year review period, two 35,000-gallon USTs were removed as part of the fuel oil tank replacement project for NHB (U.S. Navy 2008f). These tanks were located in the area designated as Site 110. The two tanks were removed on March 3 and 5, 2008. Prior to removal, the supply and return lines were flushed from inside the building to the USTs. The UST contents were then pumped into a vacuum tanker truck and transported to Petroleum Reclaiming Services Group, Inc. (PRS), in Tacoma Washington, for disposal. No holes were observed in the USTs during tank removal activities. Excavated soil with apparent hydrocarbon impacts was stockpiled, sampled, transported, and disposed of at Waste Management in Port Orchard, Washington. Approximately 2,600 tons of impacted soil were removed and disposed of.

Eight soil samples were collected prior to and immediately after the second UST was removed from the excavation on March 5, 2008. Three of the eight soil samples had concentrations of DRO greater than the MTCA Method A cleanup levels for unrestricted land use. One of these three samples was collected from the stockpiled soil that was later disposed of at Waste Management. On April 27, 2008, four sidewall samples from depths ranging from 12 to 20 feet below ground surface (bgs) and four excavation floor samples from below each end of the former UST were collected. All eight samples were below MTCA Method A cleanup levels for unrestricted land use.

During tank excavation, groundwater seeped into the excavation at a depth of approximately 7.5 to 8 feet bgs. This water contained a heavy petroleum sheen. In addition, separate-phase hydrocarbons were observed on the water surface within the west side of the excavation on February 28 and March 5, 2008. A water grab sample was collected from within the excavation on March 5, 2008. DRO, RRO, and BTEX were detected in the sample with concentrations of DRO, benzene, and total xylenes exceeding MTCA Method A cleanup levels. The accumulated groundwater with hydrocarbon impacts was pumped into 4,900-gallon tanker trucks beginning on May 13, 2008. In May 2008, a small quantity of water was observed to have accumulated inside the excavation. Although the water exhibited no visible sheen, a grab sample was collected on May 19, 2008. DRO was detected in this sample at a concentration less than the MTCA Method A cleanup level. The water removal activities concluded on May 20, 2008. Certified Cleaning Services Incorporated transported approximately 201,050 gallons of hydrocarbon-impacted water to PRS in Tacoma, Washington for treatment and disposal.

On June 17, 2008, groundwater sampling was performed in existing monitoring wells located in the vicinity of the former USTs. Groundwater samples were collected at monitoring wells MW-1, MW-3, and SB-7 and were analyzed for DRO. DRO was not detected above the method reporting limit of 200 µg/L in any of the groundwater samples. To obtain closure at this site, the Navy conducted one additional groundwater sampling event in October 2009 to confirm attainment of cleanup standards. Results of this sampling event were pending at this time of this review.

6.4.6 Additional Subsurface Investigations at the Benzene Release Area

As previously discussed in Section 4, additional site investigation and pilot testing were performed at the site during this 5-year review period including the following:

- A subsurface investigation performed in 2005 (U.S. Navy 2005d and 2006b)
- A DPE pilot test performed in 2006 (U.S. Navy 2006a and 2007b)
- Installation and operation of an active free-product skimming system (U.S. Navy 2007c, 2008c, and 2009f)

2005 Subsurface Investigation

The 2005 subsurface investigation was conducted to further assess the extent of soil and groundwater contamination in the vicinity of the NEX pump island, as well as the lateral extent of contaminated groundwater beneath the site. As described in the field report (U.S. Navy 2006b), the 2005 investigation delimited the groundwater contamination plume at the site and provided information that confirmed that soil beneath the NEX pump island was a residual

source of contamination to groundwater. The investigation included the completion of two DPE wells (DPE-894 and DPE-897) for potential pilot testing and five monitoring wells (MW-885, MW-887, MW-889, MW-890, and MW-891), as shown on Figure 4-4. In addition to the DPE and monitoring wells, soil borings were completed throughout the site (884, 888, 892, 893, 895, and 896) to assess concentrations of BTEX and TPH-G in vadose zone soil, and one air-sparge well was installed at the near-shore area (AS-886) for potential future use.

Free product was detected in wells DPE-894 and DPE-897 several days after installation and development. Elevated concentrations of BTEX and TPH-G were detected in the deep monitoring wells (MW-889, MW-890, and MW-891), confirming a continuous plume from the NEX gas station to the shoreline at Ostrich Bay. Low levels of benzene were detected in wells MW-885 and MW-887, and based on these data, the two wells generally delimit the southern and northern extent of the contaminated groundwater plume at the shoreline. The field report (U.S. Navy 2006b) recommended that a pilot test be conducted to assess DPE for interim removal of free product and as a potential long-term remedy for the source area.

2006 Dual-Phase Extraction Pilot Test

In 2006, the recommended pilot test was conducted to assess DPE as a remedial technology to address BTEX- and gasoline-contaminated groundwater and unsaturated soil beneath the source area. Prior to conducting the pilot test, baildown tests were conducted at wells MW-891, DPE-894, and DPE-897, and a pump test was conducted at well DPE-897. Groundwater sampling and groundwater level monitoring were performed in conjunction with the DPE pilot test. Groundwater samples were collected from DPE-897 prior to the pilot test, as well as after the pilot test. Groundwater samples were also collected from MW-4, MW-882, MW-889, DPE-894, and DPE-897 and from seep OF-712 after the DPE tests were completed. Groundwater levels were measured before and after the DPE pilot test at all of the monitoring wells screened in the aquifer beneath the site. The results of the bail-down tests, pump test, and pilot test were presented in a technical memorandum (U.S. Navy 2007b). It was concluded that DPE was not the most feasible means to remove free product from the source area, because extraction and treatment of large volumes of water would be required to sufficiently suppress the groundwater surface and induce migration of free product to the DPE recovery wells. However, the pilot test did demonstrate that sufficient vapor-phase petroleum extraction rates could be achieved in the coarse-grained aquifer material beneath the source area. The results also indicated that a better understanding of the extent of free product would be necessary to identify a long-term remedy for the source area as well as the downgradient portion of the site.

The DPE pilot test technical memorandum recommended the following actions to fill data gaps necessary to evaluate a feasible long-term remedy and to address free-product removal in the interim:

- Install skimmer pumps at wells DPE-894, DPE-897, and MW-891 to begin removal of free product from well locations where free product has been observed and monitor product recovery on a monthly basis.

- Monitor groundwater elevations and product thicknesses in wells DPE-894, DPE-897, MW-4, MW-889, MW-891, and MW-890 quarterly until the extent of product at the site is better known.

- Install two additional wells at the site to assess the northerly and easterly extent of free product in the source area. One of these wells could be installed by overdrilling soil boring location 895. The most beneficial location for the eastern extent would be a well between MW-889 and MW-891 in the vicinity of Haven Road.

- Install three wells screened in the Vashon Till near the NEX pump island and conduct a pilot study specifically to assess the effectiveness of soil vapor extraction (SVE) for removal of vapor from this other geologic unit at the source area.

Free-Product Removal

Because LNAPL or "free product" was observed in monitoring wells completed at and directly downgradient of the NEX gas station during field investigations conducted in 2005 and 2006, an engineering evaluation/cost analysis (EE/CA) report was prepared following completion of the DPE pilot test (U.S. Navy 2007c) to satisfy the requirements of a non-TCRA under CERCLA. The scope of the EE/CA was limited to LNAPL recovery. Efforts to address soil and dissolved-phase groundwater contamination were to be addressed in a site-wide FS. The purpose and objectives of the EE/CA report were to summarize the nature and extent of LNAPL occurrence at the site, develop preliminary removal action objectives, identify and evaluate potential removal action alternatives that could be used to remove free product, and recommend a preferred LNAPL recovery remedy. LNAPL recovery technologies evaluated include passive and active skimming, single- and dual-pump drawdown, SVE, bioslurping, DPE, and high-vacuum dual-phase extraction. Based on effectiveness, implementability, and cost criteria, active skimming of LNAPL from the existing three wells at the site (DPE-894, DPE-897, and MW-891) was selected as the preferred remedy. The decision to perform active skimming as a non-TRCA was documented in an action memorandum for the site (U.S. Navy 2008c).

Installation of a free product removal system was completed on August 5, 2009 (U.S. Navy 2009f). The recovery equipment includes pneumatic skimmer pumps, which are installed in each of three 4-inch-diameter recovery wells. Although the action memorandum specified that three existing wells would be used in the active skimming system, the Navy later decided to

install three new wells in the vicinity of the existing wells that exhibited the presence of free product downgradient of the NEX gas station. Initially, three wells were drilled at the site (RW-1, RW-2, and RW-3). A fourth well, RW-4, was drilled after no free product was detected in RW-1. Very little free product was detected in RW-4 as well. Recovery wells were installed to a depth of approximately 60 feet bgs using sonic drilling methods. RW-2, RW-3, and RW-4 are connected via underground piping to a 300-gallon, double-walled tank. The tank and an air compressor are housed in a secured compound. The system began operation in late July 2009 and was shut down on September 11, 2009, because the tank was full of petroleum-contaminated water with no free product (Thelin 2009a).

Although the free product removal system remains shut down, groundwater elevations and product thicknesses have been measured in RW-2, RW-3, and RW-4 four times (September 16, November 19, and December 1 and 18, 2009) since system shutdown (Thelin 2009b and 2009c). Groundwater elevations and product thicknesses have been measured at RW-1 and MW-890 twice since system shutdown. Free product was detected with thicknesses less than or equal to 0.09 foot in RW-2 on November 19 and December 1 and 12, 2009, at RW-3 on December 12, 2009, and at RW-4 on September 16, 2009. Free product was not detected in RW-1 or MW-890. Furthermore, groundwater elevations and product thicknesses have been measured at DPE-894, DPE-897, and MW-891 on November 19 and December 1, 2009. The maximum detected product thickness at these three locations was 2.71 feet at MW-891 on November 19, 2009, and the minimum was 0.08 foot at DPE-897 on December 18, 2009. Because substantial thicknesses of free product were detected in wells DPE-894 and MW-891, free product was bailed from these wells on December 1, 2009. Twenty-eight liters of free product were removed from DPE-897, and 16 liters were removed from MW-891.

Conceptual Site Model

The hydrogeologic data collected at the Benzene Release Area during this 5-year review period was combined with data from previous investigations conducted at the site. Based on the combined data, the conceptual site model was revised (see Figure 6-1). The site is mantled by a fill layer that varies in thickness and is generally composed of reworked glacial till. Vashon Till deposits underlie the fill layer and consist of dense to very dense silty, gravelly sands to sandy silts with gravel. Perched groundwater of limited thickness was encountered in the till and was discontinuous across the site. Wells screened within the till include HC-2, HC-4, and HC-5 (Figure 4-4). The till layer was observed to thin to the east toward the near-shore area of the site and was not observed in the majority of borings completed along the shoreline. Vashon Advance Outwash was identified beneath the till across the entire site and generally consists of gravelly sands to sandy gravels. DPE--894, DPE--897, MW--885, MW-887, MW--889, MW--890, and MW-891 were screened in the Vashon Advance Outwash. Groundwater was present in the outwash deposits as a continuous aquifer from the NEX area to the shoreline. The outwash deposits were noted to be finer grained and siltier in the near-shore area. The outwash deposits

also appear to thin to the east toward the shoreline. The outwash was observed to be underlain by lower permeability sandy silts with interbedded silt and clays that were not saturated.

Groundwater surface elevation contours based on depth-to-water measurements collected in October 2006 from wells completed in the Vashon Advance Outwash are shown in Figure 6-2. The inferred groundwater flow in the aquifer based on the October 2006 data was easterly to southeasterly toward Ostrich Bay, which is consistent with previously inferred groundwater flow conditions observed at the site. Based on the October 2006 data, the average hydraulic gradient across the site was approximately 0.013 foot/foot along the flow path from DPE-894 to MW-885. The hydraulic gradient steepens significantly in the eastern portion of the site to approximately 0.1 foot/foot along the flow path from MW-4 to MW-882 near the shoreline. The change in gradient near the shoreline is consistent with the surface topography, as shown in Figure 6-2. The average hydraulic gradient in the NEX area is much shallower at approximately 0.005 foot/foot. Based on the hydraulic gradient, hydraulic conductivity values estimated by the pumping test at DPE-897, and an assumed effective porosity of 0.3, the average groundwater flow velocity across the site is estimated to range from 2.4 to 2.7 feet/day (U.S. Navy 2007b). The average groundwater velocity was estimated at 0.48 to 4 feet/day using aquifer performance test data from wells MW-885 and MW-889 in the eastern and central portions of the site, respectively, and 2005 hydraulic gradient data (U.S. Navy 2006b). The 2005 and 2006 data suggest that groundwater velocity is slowest in and downgradient of the source area, based on apparent hydraulic gradient, with groundwater velocity increasing along with the hydraulic gradient as groundwater approaches the shoreline.

Based on field screening and soil analytical data and the presence of free product on the groundwater surface of the Vashon Advance Outwash aquifer, it is apparent that gasoline released at the pump island area has migrated through the till and into the outwash deposits (Vashon Advance Outwash) to the groundwater surface (U.S. Navy 2006b) (see Figure 6-1). The highest concentrations of BTEX and TPH-G are found in soil and groundwater closest to the pump island. Moving easterly, gasoline impacts were not observed in unsaturated soil and were evident only within the saturated zone, indicating that the contamination has spread laterally downgradient of the source area within the saturated zone. This downgradient zone of residual impact has been affected by seasonal groundwater fluctuations and has created a "smear zone" of up to 5 feet in thickness within the saturated soils. Furthermore, the highest concentrations of gasoline constituents tend to be along a line from the NEX gas station to MW-4 (see Figures 6-3 and 6-4). The concentrations of BTEX and TPH-G generally attenuate to the north and south of the axis of the plume, as indicated in Figure 6-3 by the low concentrations of benzene at wells MW-885 and MW-887. Concentrations of benzene also attenuate near the shoreline at OF-712 (see Table 6-2).

The extent of free product adjacent to the NEX pump island was estimated based on the 2006 free-product measurements. Free product was measured in wells MW-891, DPE-894, and DPE-897 located adjacent to the NEX pump island at that time (Figure 6-3). Approximately 0.2 to 0.25 foot of product is estimated to exist on the groundwater surface in the NEX area (U.S. Navy 2007b). The estimated extent of free product on the groundwater surface covers an area of approximately 16,000 square feet (Figure 6-3). Assuming a product thickness of 0.2 foot, as measured during the bail-down test, the estimated volume of product on the groundwater surface is approximately 9,000 gallons. This estimate is assumed to be conservatively high and will be revised based on the additional investigation work being performed in 2010.

6.4.7 OU 1 Inspection and Maintenance Activities

All OU 1 inspection activities since the last 5-year review were performed in accordance with the inspection and maintenance plan (U.S. Navy 2003e) and the revised inspection and maintenance plan (U.S. Navy 2008b), as summarized in Table 4-2, with one minor exception. During the winter 2004 inspection event conducted on December 10, the shoreline area was not inspected for weeds. Since weed growth is generally limited during the winter months, there were no impacts to the remedy. In addition to the routine quarterly inspections, a site inspection is required within 72 hours of a significant storm event, which is defined as a 2-year storm for Bremerton, Washington. The National Oceanic and Atmospheric Administration defines the 2-year storm for Bremerton to be 1.37 inches of rain in a 6-hour period or 2.92 inches of rain in a 24-hour period. During this 5-year review period, significant storms occurred on November 6 and December 14, 2006, November 15 and December 3, 2007, November 6, 2008, and January 7, 2009. Significant erosion only occurred during the December 3, 2007 storm event, where mulch was found to have eroded from the shoreline beds. The eroded mulch was redistributed and augmented with new mulch following the storm event.

Both routine and nonroutine maintenance activities were performed in accordance with the inspection and maintenance plan. The routine maintenance activities that were performed during the last 5-year review period included (U.S. Navy 2005h, 2005i, 2005j, 2006c, 2007d, 2008e, 2009g, 2009h, and 2009i):

- Replacing rocks removed from the low rock shelf and the armor stone revetment
- Removing dead vegetation from the shoreline area
- Trimming vegetation that was encroaching on walkways and stairs
- Watering newly planted vegetation on an as-needed basis
- Replacing broken and missing shellfish warning signs

- Replacing rock on the seep/outfall rock splash pad areas in the vicinity of the seawall
- Weeding shoreline vegetation areas and gravel pathways
- Placing mulch on shoreline vegetation areas

The nonroutine maintenance activities that were performed during the last 5-year review period included (U.S. Navy 2005h, 2005i, 2005j, 2006c, 2007d, 2008e, 2009g, 2009h, and 2009i):

- Repairing the granite stairs immediately south of the pocket beach and the stairs in the vicinity of the lift station in 2005, which had been undercut by erosion and wave action
- Repairing a sinkhole adjacent to the walking trail south of the Dowell Road cul-de-sac by backfilling and mulching, which was caused by a water line break during monitoring well installation in the summer of 2005
- Repairing cracks in asphalt along the walking trail south of Dowell Road in 2006
- Replanting dead vegetation in the shoreline area in January 2007 and spring 2008
- Repairing areas of surface erosion along the top of the armor stone revetment adjacent to the helicopter pad during spring and fall 2007
- Repairing cracks in the Wencker Way cover area in October 2007 by sealing and asphalt paving
- Repairing cracks in the easternmost portion of the Romer Drive cover area in October 2007 by sealing and asphalt paving
- Placing gravel on the southern construction debris landfill in fall 2007 in an area where erosion had occurred
- Planting trees and shrubs in spring 2008 on the informal trails leading down to the pocket beach to prevent the use of these paths
- Resurfacing the gravel paths leading to the pocket beach in fall 2008

Additional maintenance activities that may be required in the future are the following:

- Deterioration of the seawall surface in areas which had been previously patched has been observed over this 5-year review period. Although this deterioration does not appear to impact the structural integrity of the seawall, the seawall should continue to be monitored. If monitoring indicates an impact to the structural integrity, then repairs should be implemented.

- The crack in the asphalt along the walking trail south of Dowell Road has reopened. When the crack exceeds 1/8 inch in width, it should be resealed.

- Continue to monitor the shoreline vegetation affected by the ordnance investigation, and replant and augment mulch as needed.

6.5 RESULTS OF SITE INSPECTION

The site inspection checklist is included as Appendix A. This section contains a summary of the site inspection findings. The site visit occurred on September 17, 2009 and was conducted by the following personnel:

- Douglas Thelin, NAVFAC NW
- David Robinson, NAVFAC NW
- Michael Meyer, URS Corporation
- Debbie Rodenhizer, URS Corporation

The site visit consisted of inspecting all portions of the site covered by institutional controls or requiring ongoing remedy maintenance.

The site walk verified that the remedial action components are being regularly maintained and that the institutional controls requirements for Sites 101, 101-A, 103, and 110 are being met. Institutional controls inspections are being performed and documented yearly, and documentation is available. During this 5-year review period, the City of Bremerton installed a water pipe through the southern side of JPHC. The original alignment of the water pipe passed through the Root Court cul-de-sac where excavation institutional controls apply. NAVFAC NW was informed of the water pipe installation and recommended a slight reroute to avoid the cul-de-sac. The site inspection for this 5-year review verified that the reroute had been implemented.

At Building 100, a new asphalt overlay was placed during this 5-year review period. At Building 101, the asphalt cover was extended slightly to provide more comprehensive coverage of the contaminated soil.

Shellfish harvesting restrictions signs were replaced during this 5-year review period with more durable signs.

The site inspection verified that regular inspections and maintenance of the vegetated soil covers and the shoreline protection features are being performed. However, minor erosion in some areas and the presence of some invasive plant species during the time of the site inspection demonstrate that maintenance activities are an ongoing necessity.

6.6 RESULTS OF INTERVIEWS

Interview candidates consisted of persons familiar with the CERCLA actions at JPHC/NHB. Interviewees were selected from the Navy (including NAVFAC NW and NHB), EPA, Ecology, and the community. Interview instructions and questions were sent to potential interviewees via e-mail, and responses to questions were returned either by e-mail or telephone (at the discretion of the interviewee). Not all those invited to comment chose to do so. Interview responses are documented in Appendix B. Highlights of the interview responses are summarized in the following sections.

6.6.1 Navy Personnel

The Navy respondents (six individuals) concurred that the OU 1 remedy continues to be effective, as long as maintenance activities continue. Most Navy respondents reported that the institutional controls and land use restrictions continued to be effective and reported no institutional controls violations. Two Navy respondents, however, reported that residents of the Navy housing tended to ignore the institutional controls, and some minor vandalism of remedy elements (e.g., signage and shoreline protection rocks) has been reported. Several of the respondents noted the ongoing effort to revise the remedy for the Benzene Release Area.

The respondents felt that the monitoring data have been timely and of acceptable quality, although laboratory method limitations continue to result in uncertainty regarding ordnance compounds in marine tissue.

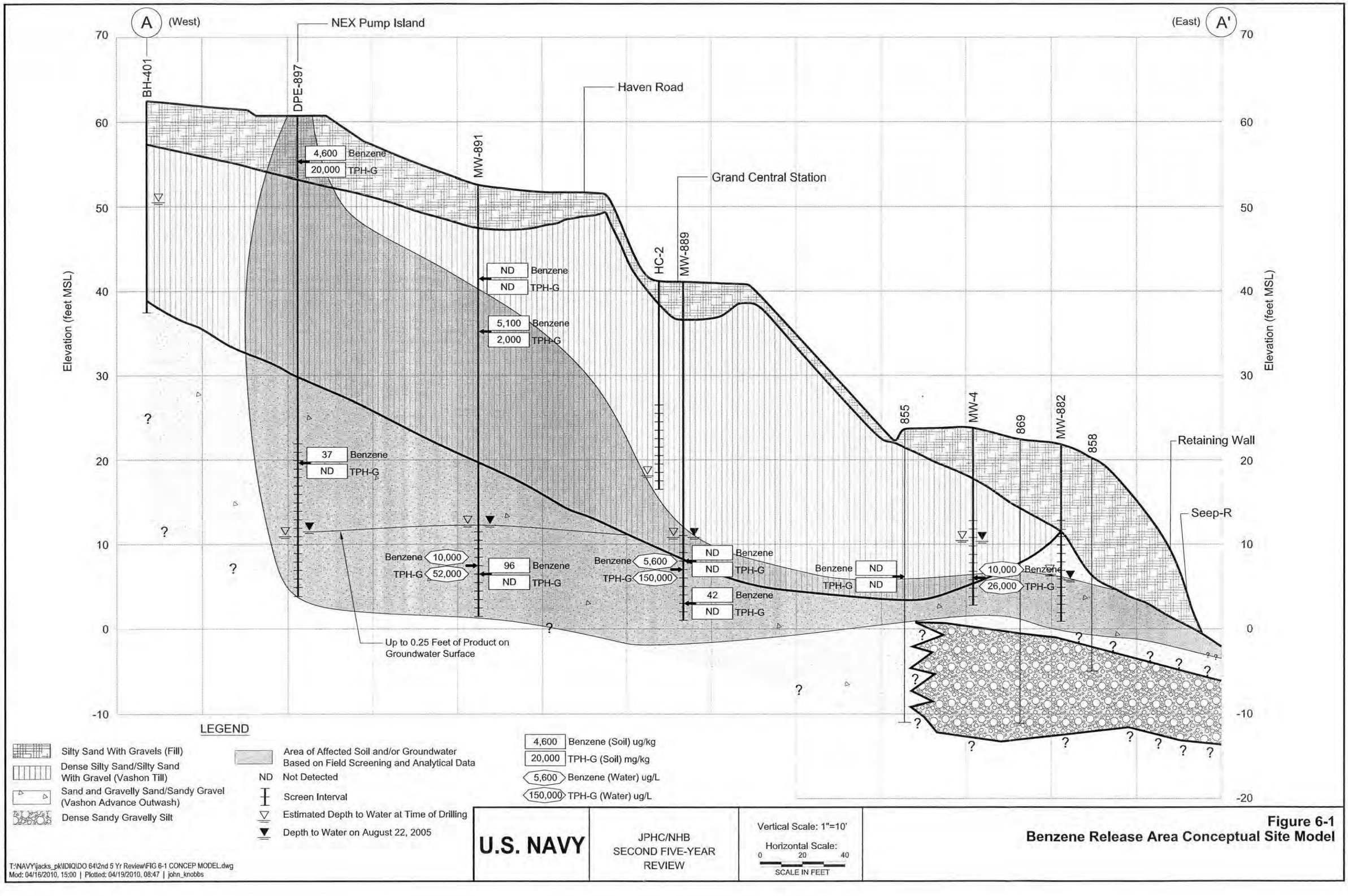
Several Navy respondents noted the difficulties in encouraging meaningful community participation, but reported no community concerns.

6.6.2 Agency Personnel

Ecology stated that they would not be responding to the interview request because EPA is the lead regulatory agency for the site. At the time of preparation of this draft, EPA had not responded to the interview request.

6.6.3 Community

Although several attempts were made to obtain input from the community (focused on attendees at recent RAB meetings), only the Suquamish Tribe indicated a desire to respond. At the time of preparation of this draft, the Suquamish Tribe had not responded to the interview request.



LEGEND

- Silty Sand With Gravels (Fill)
- Dense Silty Sand/Silty Sand With Gravel (Vashon Till)
- Sand and Gravelly Sand/Sandy Gravel (Vashon Advance Outwash)
- Dense Sandy Gravelly Silt
- Area of Affected Soil and/or Groundwater Based on Field Screening and Analytical Data
- ND Not Detected
- Screen Interval
- Estimated Depth to Water at Time of Drilling
- Depth to Water on August 22, 2005

- 4,600 Benzene (Soil) ug/kg
- 20,000 TPH-G (Soil) mg/kg
- 5,600 Benzene (Water) ug/L
- 150,000 TPH-G (Water) ug/L

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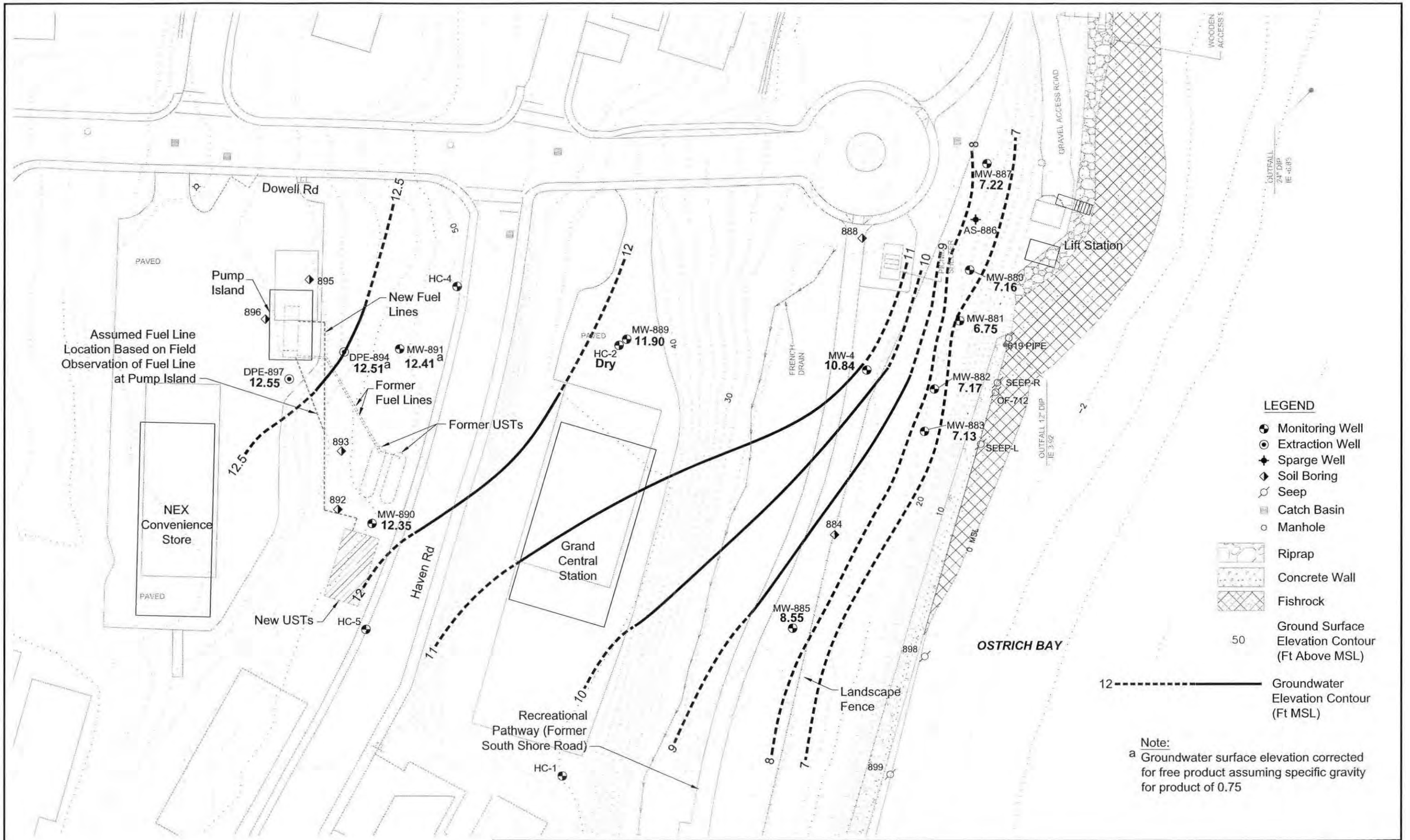
U.S. NAVY

JPHC/NHB
SECOND FIVE-YEAR
REVIEW

Vertical Scale: 1"=10'

Horizontal Scale:
0 20 40
SCALE IN FEET

Figure 6-1
Benzene Release Area Conceptual Site Model



U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 25 50 SCALE IN FEET	**Figure 6-2 Groundwater Surface Elevation Contours, October 2006**

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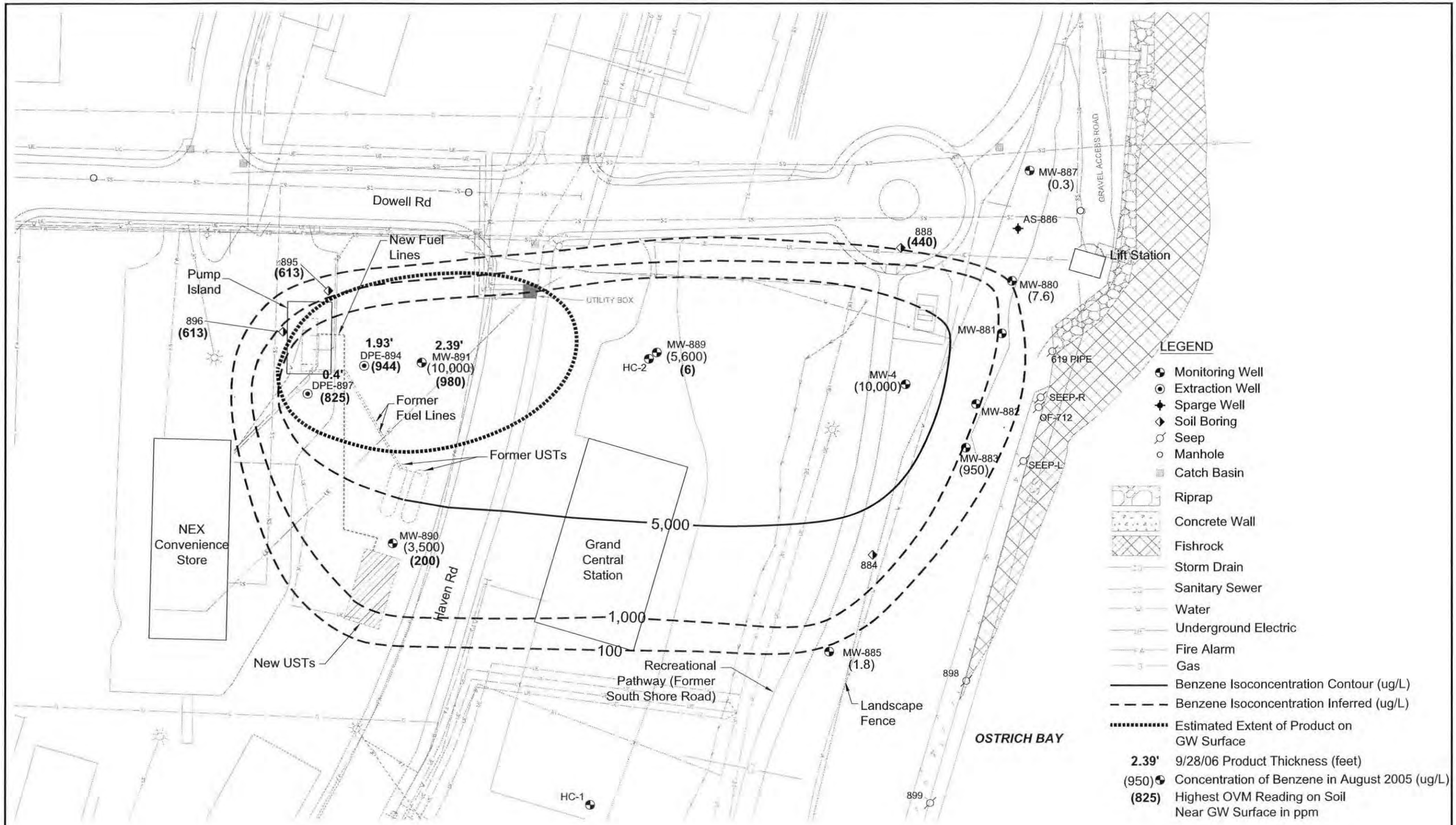

U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 25 50 SCALE IN FEET	**Figure 6-3** **Benzene Isoconcentration Map for Groundwater and Estimated Extent of Free Product**

T:\NAVY\jacks_pk\IDIQ\DO 64\2nd 5 Yr Review\FIG 6-3 FREE PROD.dwg
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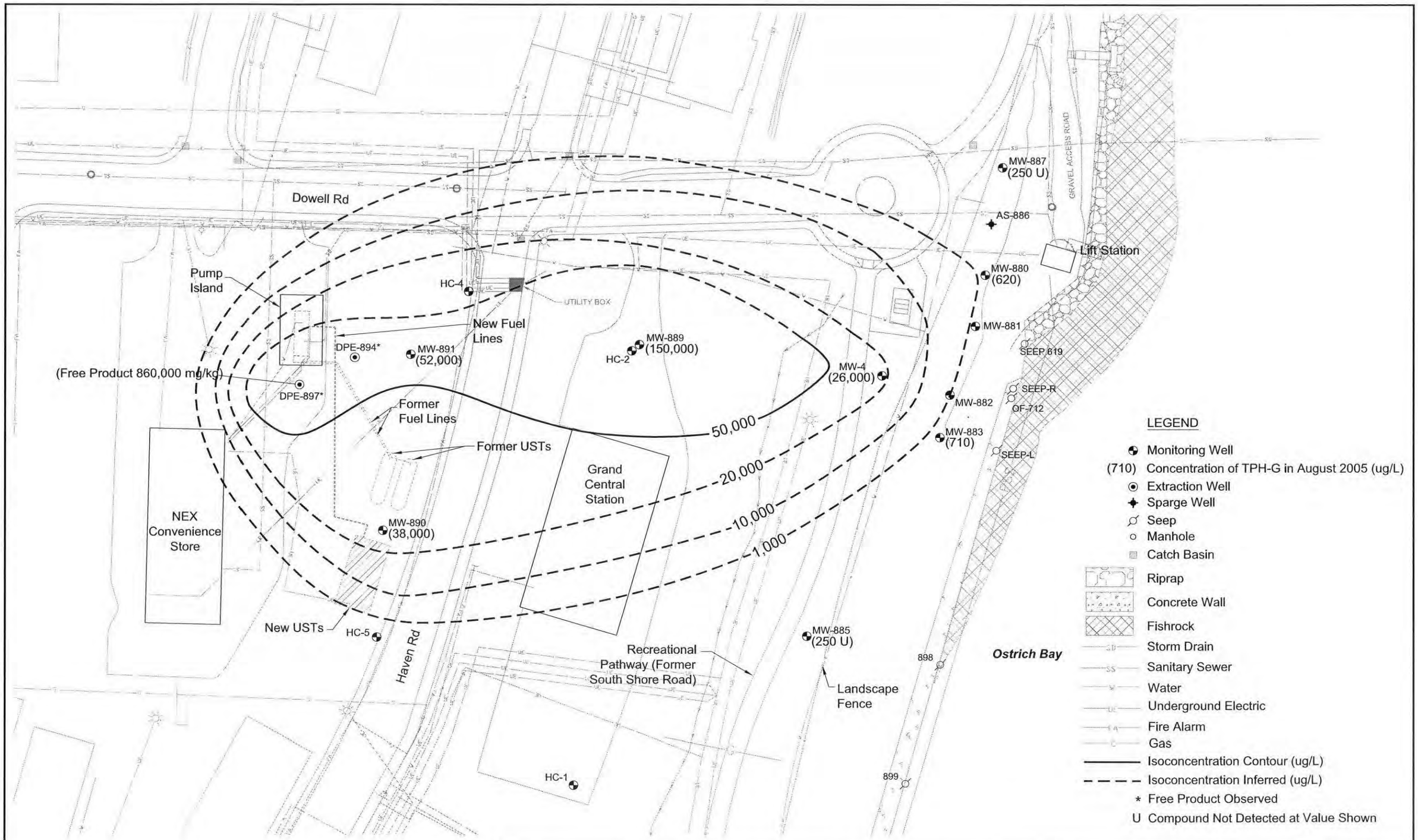

U.S. NAVY	JPHC/NHB SECOND FIVE-YEAR REVIEW	0 25 50 SCALE IN FEET	**Figure 6-4** **TPH-G Isoconcentration Contour Map for Groundwater** **August 2005**

T:\NAVY\jacks_pk\IDIQ\DO 64\2nd 5 Yr Review\FIG 6-4 TPH-G.dwg
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Table 6-1
Summary of Analytical Results for Chlorinated VOCs in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	1,1-DCE (µg/L)	TCE (µg/L)	Vinyl Chloride (µg/L)
Remediation Goal			1.93	55.6	2.92
101	OF-709	06/25/02	0.5 U	0.5 U	0.5 U
		11/06/02	0.5 U	0.5 U	0.5 U
		06/16/03	0.5 U	0.5 U	0.5 U
		06/29/04	0.5 U	0.5 U	0.5 U
		11/16/04	0.5 U	0.5 U	0.5 U
		07/19/05	0.5 U	0.5 U	0.5 U
		08/07/06	0.5 U	0.5 U	0.5 U
		07/30/07	0.5 U	0.5 U	0.5 U
		07/30/08	0.5 U	0.5 U	0.5 U
		07/06/09	0.5 U	0.5 U	0.5 U
103	SP-703	06/18/03	0.5 U	0.48 J	0.5 U
		07/01/04	0.5 U	0.49 J	0.5 U
		11/15/04	0.5 U	0.5	0.5 U
		07/20/05	0.5 U	0.77	0.5 U
		08/07/06	0.5 U	1.8	0.5 U
		07/31/07	0.5 U	1.2	0.5 U
		07/30/08	0.5 U	1.1	0.5 U
		07/07/09	0.5 U	1.7	0.5 U
	OF-705[a]	11/06/02[b]	0.5 U	40	0.5 U
		06/16/03	0.5 U	19	0.5 U
		07/01/04	0.5 U	36	0.5 U
		11/15/04	0.5 U	26	0.5 U
		07/20/05	0.5 U	32	0.5 U
		07/30/07	0.5 U	46	0.21 J
		07/07/09	0.5 U	35	0.12 J
	SP-707[c]	06/25/02	0.5 U	0.5 U	0.5 U
		11/06/02	0.5 U	0.5 U	0.5 U
		06/16/03	0.5 U	0.5 U	0.5 U
		06/29/04	0.5 U	0.5 U	0.5 U
		11/16/04	0.5 U	0.5 U	0.5 U
		07/19/05	0.5 U	0.5 U	0.5 U
		08/08/06	0.5 U	0.5 U	0.5 U

Table 6-1 (Continued)
Summary of Analytical Results for Chlorinated VOCs in Seeps and Outfalls From November 2002 Through July 2009

[a]Samples from this location were inadvertently not analyzed for chlorinated VOCs in 2006 and 2008.
[b]These data were not included in the fall 2002 long-term monitoring report (U.S. Navy 2003d). Data shown for this date and location were downloaded from the Naval Installation Restoration Information Solution database. The chain of custody confirms that a sample from this location was tested for chlorinated VOCs.
[c]No sample from this location was collected in 2007, 2008, and 2009 because salinity was greater than 1%, indicating the water was not representative of groundwater.

Notes:
DCE - dichloroethene
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
MDL - method detection limit
MRL - method reporting limit
µg/L - microgram per liter
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-2
Summary of Analytical Results for Benzene in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	Benzene (µg/L)
Remediation Goal			43
101	SP-710	06/25/02	0.5 U
		11/06/02	0.5 U
		06/30/03	0.5 U
		06/29/04	0.5 U
		11/15/04	0.5 U
		07/19/05	0.5 U
		08/08/06	0.5 U
		07/30/07	0.5 U
		07/30/08	0.5 U
		07/06/09	0.07 J
	SP-711[a]	11/06/02	0.50 U
		06/30/04	0.50 U
		11/16/04	0.50 U
	OF-712	06/25/02	**150 J**
		11/05/02	**51**
		06/16/03	**90 J**
		06/29/04	**44**
		11/16/04	27
		07/19/05	**53**
		10/19/06	**50**
		07/30/07	**150**
		07/31/08	**67**
		07/06/09	**59**

[a]No sample was collected from this location in summer 2002 and 2003 because of insufficient flow, and from summer 2005 to 2009 because salinity was greater than 1%, indicating the water was not representative of groundwater.

Notes:
Bolded value indicates it exceeds or is equal to the remediation goal.
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
MDL - method detection limit
MRL - method reporting limit
µg/L - microgram per liter
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-3
Summary of Analytical Results for Petroleum Hydrocarbons in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	GRO (µg/L)	DRO (µg/L)	RRO (µg/L)
Remediation Goal			1000	N/A	N/A
101	SP-710	06/25/02	50 U	100 J	500 U
		11/06/02	50 U	250 U	500 U
		06/16/03	50 U	250 U	500 U
		06/29/04	250 U	240 U	480 U
		11/15/04	250 U	250 U	500 U
		07/19/05	250 U	250 U	500 U
		08/08/06	250 U	260 U	27 J
		07/30/07	250 U	260 U	520 U
		07/30/08	250 U	13 J	29 J
		07/06/09	250 U	620 Z	480 Z
	SP-711[a]	11/06/02	50 U	250 U	67 J
		06/30/04	250 U	240 U	65 J
		11/16/04	250 U	41 J	110 J
101-A	SP-715	06/25/02	50 U	250 UJ	500 UJ
		11/05/02	44 J	250 U	500 U
		06/16/03	50 U	250 U	500 U
		06/30/04	250 U	250 U	490 U
		11/15/04	250 U	250 U	500 U
		07/20/05	250 U	250 U	500 U
		08/07/06	17 J	250 U	500 U
		07/31/07	250 U	270 U	530 U
		07/31/08	250 U	24 J	32 J
		07/06/09	13 J	230 Z	170 U

[a]No sample was collected from this location in summer 2002 and 2003 because of insufficient flow, and from summer 2005 to 2009 because salinity was greater than 1%, indicating the water was not representative of groundwater.

Notes:
DRO - diesel-range organics
GRO - gasoline-range organics
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
MDL - method detection limit
MRL - method reporting limit
µg/L - microgram per liter
N/A - not applicable
RRO - residual-range organics
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.
UJ - The compound was undetected, and the detection limit is estimated.
Z - The pattern of peaks present on the laboratory chromatograms is not indicative of diesel or motor oil.

Table 6-4
Summary of Analytical Results for Chlordane in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	gamma-Chlordane (µg/L)	alpha-Chlordane (µg/L)	Total Chlordane (µg/L)
Remediation Goals			N/A	N/A	0.0022
101-A	OF-716	06/25/02	0.048 U	0.048 U	**0.048 U**
		11/05/02	0.0096 U	0.0096 U	**0.0096 U**
		06/16/03	0.0096 U	0.0096 U	**0.0096 U**
		06/30/04	0.0096 U	0.0096 U	**0.0096 U**
		11/15/04	0.0098 U	0.0098 U	**0.0098 U**
		07/19/05	0.00048 U	0.00048 U	0.00048 U
		08/07/06	0.00049 Ui	0.00048 Ui	0.00049 Ui
		07/31/07	0.0098 U	0.0098 U	**0.0098 U**
		07/31/08	0.0005 U	0.0005 U	0.0005 U
		07/06/09	0.001 U	0.0009 Ui	0.001 U
103	SP-703[a]	07/01/04	0.0096 U	0.0096 U	**0.0096 U**
		11/15/04	0.0097 U	0.0097 U	**0.0097 U**
		07/20/05	0.00049 U	0.00049 U	0.00049 U
		08/07/06	0.00048 Ui	0.00048 Ui	0.00048 Ui
		07/31/07	0.0098 U	0.0098 U	**0.0098 U**
		07/30/08	0.00049 U	0.00049 U	0.00049 U
		07/07/09	0.00097 U	0.00087 U	0.00097 U
	OF-705	06/25/02	0.048 U	0.048 U	**0.048 U**
		11/06/02	0.0096 U	0.0096 U	**0.0096 U**
		06/16/03	0.0096 U	0.0096 U	**0.0096 U**
		07/01/04	0.0096 U	0.0096 U	**0.0096 U**
		11/15/04	0.010 U	0.010 U	**0.010 U**
		07/20/05	0.00049 U	0.00049 U	0.00049 U
		08/07/06	0.00048 Ui	0.00048 Ui	0.00048 Ui
		07/30/07	0.00045 J	0.0098 U	**0.0098 U**
		07/31/08	0.00049 U	0.00049 U	0.00049 U
		07/07/09	0.00098 U	0.00088 U	0.00098 U
	SP-707[b]	06/25/02	0.048 U	0.048 U	**0.048 U**
		11/06/02	0.0096 U	0.0096 U	**0.0096 U**
		06/16/03	0.01 U	0.0097 U	**0.01 U**
		06/29/04	0.0098 U	0.0098 U	**0.0098 U**
		11/16/04	0.0098 U	0.0098 U	**0.0098 U**
		07/19/05	0.0017 U	0.00049 U	0.0017 U
		08/08/06	0.0000096 Ui	0.0000096 Ui	0.0000096 Ui

Table 6-4 (Continued)
Summary of Analytical Results for Chlordane in Seeps and Outfalls From November 2002 Through July 2009

[a]No sample from this location was analyzed for pesticides in 2003. No explanation for this omission was identified.
[b]No sample was collected from this location in 2007, 2008, and 2009 because salinity was greater than 1%, indicating the water was not representative of groundwater.

Notes:
Bolded value indicates it exceeds or is equal to the remediation goal.
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
MDL - method detection limit
MRL - method reporting limit
µg/L - microgram per liter
N/A - not applicable
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.
Ui - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL. The MRL/MDL was elevated because of a chromatographic interference.

Table 6-5
Summary of Analytical Results for Metals and Cyanide in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	Total Metals (µg/L)				Dissolved Metals (µg/L)					Cyanide (mg/L)
			Arsenic	Beryllium	Mercury	Thallium	Copper	Lead	Nickel	Silver	Zinc	
Remediation Goal			3.7	0.0793	0.1	1.56	4.8	5.8	7.9	1.2	81	0.001
101	OF-709	06/25/02	0.97 J	0.044	**0.1 U**	0.007 J	2.9 J	0.276 UJ	0.2 J	0.01 UJ	6.2	**0.01 U**
		11/06/02	1.21 J	0.072 J	**0.1 U**	0.011	1.06 J	0.019 U	0.33	0.01 U	10.8 J	**0.01 U**
		06/16/03	1.08 J	0.014 J	**0.1 U**	0.005 J	1.26	0.02 U	0.33	0.008 U	12.2	**0.01 U**
		06/29/04	1.63 J	0.058 J	0.04 U	0.007 J	0.874	0.028	0.29	0.005 U	13.6	**0.01 U**
		11/16/04	0.73 J	0.023	0.06 U	0.004 U	1.25	0.023	0.28	0.005 U	6.86	**0.01 U**
		07/19/05	0.4 J	0.0077 J	0.08 U	0.02 U	0.724	0.008 U	0.3	0.002 U	3.24	**0.08**
		08/07/06	0.39 J	0.0069 J	0.02 U	0.0008 U	1.56	0.013 J	0.42	0.02 U	7.47	**0.007 J**
		07/30/07	1.12	0.003 U	0.03 U	0.02 U	1.04	0.031 U	0.38	0.02 U	2.21 J	**0.01 U**
		07/30/08	0.7 U	0.04 U	0.05 U	0.005 U	1.7	0.022	3.32	0.009 J	4.96	**0.01 U**
		07/06/09	1.58	0.020 U	**0.2 U**	0.02 U	1.16	0.030 U	0.71	0.030 U	1.40 U	**0.01 U**
	SP-710	06/25/02	1.52 J	0.046	**0.1 U**	0.013 J	0.84 UJ	0.094 UJ	0.3 J	0.01 UJ	1.1	**0.01 U**
		11/06/02	0.2 J	0.011 J	**0.1 U**	0.006	0.26 J	0.03 U	0.5	0.01 U	0.5 J	**0.01 U**
		06/16/03	0.44 J	0.004 J	**0.1 U**	0.005 J	0.18	0.02	0.41	0.014 U	0.8	**0.01 U**
		06/29/04	0.86 J	0.013 J	0.04 U	0.008 J	0.542	0.048	0.4	0.005 U	0.57	**0.01 U**
		11/15/04	0.42 J	0.003 U	0.06 U	0.002 U	0.25	0.043	0.4	0.005 U	0.57	**0.01 U**
		07/19/05	0.56 J	0.0095 J	0.08 U	0.02 U	0.616	0.022	0.66	0.003 J	1.11	**0.04**
		08/08/06	0.43 J	0.0046 J	0.02 U	0.0008 U	0.33	0.009 J	0.61	0.02 U	0.59	**0.01 U**
		07/30/07	0.82	0.003 U	0.03 U	0.02 U	0.29	0.022 U	0.89	0.02 U	0.57 UJ	**0.01 U**
		07/30/08	0.7 U	0.04 U	0.05 U	0.007 U	0.62	0.033	3.41	0.009 U	1.74 U	**0.01 U**
		07/06/09	1.76	0.020 U	**0.2 U**	0.02 U	0.33 U	0.030 U	1.05	0.030 U	0.63 U	**0.01 U**
	SP-711[a]	11/06/02[b]	2.91 J	**0.151 J**	**0.34**	0.07	0.91 J	0.044 U	1.26	0.03 U	4.3 J	**0.01 U**
		06/30/04	1.41 J	0.014 J	0.04 U	0.014 J	0.76	0.148	1.46	0.005 J	2.78	**0.01 U**
		11/16/04	2.64 J	0.071	**0.12 J**	0.016 J	1.24	0.026	0.91	0.033	4.35	**0.01 U**
	OF-712	06/25/02	0.69 J	0.002 J	**0.1 U**	0.002 U	0.13 UJ	0.018 UJ	0.3 J	0.01 UJ	0.4 U	**0.01 U**
		11/05/02[b]	0.8 J	0.004 J	**0.1 U**	0.002 J	0.13 J	0.011 U	1.3	0.01 U	1 J	**0.01 U**

Table 6-5 (Continued)
Summary of Analytical Results for Metals and Cyanide in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	Total Metals (µg/L)				Dissolved Metals (µg/L)					Cyanide (mg/L)
			Arsenic	Beryllium	Mercury	Thallium	Copper	Lead	Nickel	Silver	Zinc	
		06/16/03	0.88 J	0.006 UJ	**0.1 U**	0.004 U	0.08 J	0.05	0.63	0.014 U	0.4 J	**0.006 J**
		06/29/04	0.9 J	0.015 J	0.04 U	0.001 U	0.135	0.009 U	0.66	0.005 U	0.65	**0.01 U**
		11/16/04	1.04 J	0.006 J	0.06 U	0.001 U	0.11	0.009 U	0.62	0.005 U	0.28 J	**0.01 U**
		07/19/05	0.34 J	0.0024 J	**0.2 U**	0.02 U	0.048 J	0.008 U	0.82	0.002 U	0.29 J	**0.06**
		08/08/06	0.48 J	0.0036 J	0.02 U	0.0008 U	0.06 J	0.061	0.84	0.023 U	0.52	**0.003 J**
		07/30/07	1.6	0.003 U	0.03 U	0.02 U	0.22	0.056 U	1.06	0.02 U	0.95 UJ	**0.01 U**
		07/31/08	0.7 U	0.04 U	0.05 U	0.005 U	1.78	0.045	5.5	0.02	3.31 U	**0.01**
		07/06/09	2.19	0.020 U	**0.2 U**	0.02 U	0.37 U	0.031 U	1.25	0.030 U	0.76 U	**0.01 U**
	SP-713	06/25/02	0.49 J	**0.104**	**0.1 U**	0.01 J	0.18 UJ	0.049 UJ	0.3 J	0.01 UJ	0.6 U	**0.004 J**
		11/05/02[b]	1.31 J	0.066 J	**0.1 U**	0.019 J	0.43 J	0.024 U	0.43	0.01 U	1.1 J	**0.01 U**
		06/16/03	0.4 J	0.01 J	**0.1 U**	0.005 J	0.23	0.02 U	0.42	0.008 U	0.8	**0.01 U**
		06/30/04	0.44 J	0.012 J	0.04 U	0.006 J	0.14	0.077	0.48	0.005 U	0.57	**0.01 U**
		11/16/04	0.55 J	0.015 J	0.06 U	0.009 J	0.22	0.014 J	0.36	0.005 U	0.9	**0.01 U**
		07/20/05	0.9 J	0.01 J	0.08 U	0.004 U	0.51 J	0.03 J	2.49	0.004 U	1.76	**0.01**
		08/08/06	0.79	0.02 U	0.02 U	0.003 U	0.61	0.015 J	0.79	0.004 U	4.2 J	**0.01 U**
		07/31/07	0.58	0.003 U	0.03 U	0.02 U	0.2	0.02 U	0.74	0.003 U	0.66 UJ	**0.01 U**
		07/31/08	0.7 U	0.04 U	0.05 U	0.006 J	0.39	0.015 J	3.81	0.009 U	1.45 U	**0.01 U**
		07/07/09	0.5 J	0.020 U	**0.2 U**	0.02 U	0.24 U	0.030 U	1.13	0.030 U	0.50 U	**0.01 U**
101-A	SP-715	06/25/02	1.02 J	0.002 U	**0.1 U**	0.002 U	0.1 UJ	0.019 UJ	0.5 J	0.01 UJ	10.4	**0.01 U**
		11/05/02[b]	2.36 J	0.004 J	**0.1 U**	0.004 J	0.21 J	0.019 U	0.89	0.01 U	21 J	**0.01 U**
		06/16/03	0.65 J	0.006 UJ	**0.1 U**	0.004 U	0.14	0.02 U	0.59	0.008 U	12.4	**0.01 U**
		06/30/04	1.09 J	0.002 UJ	0.04 U	0.001 U	0.07 J	0.023	0.74	0.005 U	12.5	**0.01 U**
		11/15/04	1.29 J	0.002 U	0.06 U	0.001 U	0.27	0.009 U	0.84	0.005 U	13.9	**0.01 U**
		07/20/05	0.83 J	0.002 J	0.08 U	0.02 U	0.093 J	0.008 U	0.73	0.002 U	14.9	**0.02**
		08/07/06	1.76	0.02 U	0.02 U	0.003 U	0.22	0.03	0.78	0.004 U	21.2 J	**0.01 U**
		07/31/07	1.62	0.003 U	0.03 U	0.02 U	0.17 J	0.021 U	0.82	0.02 U	24.5 J	**0.004 J**
		07/31/08	1.7 J	0.04 U	0.05 U	0.005 U	0.27	0.024	3.68	0.072	80.4	**0.01 U**

Table 6-5 (Continued)
Summary of Analytical Results for Metals and Cyanide in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	Total Metals (µg/L)				Dissolved Metals (µg/L)					Cyanide (mg/L)
			Arsenic	Beryllium	Mercury	Thallium	Copper	Lead	Nickel	Silver	Zinc	
		07/06/09	1.67	0.020 U	**0.2 U**	0.02 U	0.16 U	0.030 U	1.1	0.030 U	46.6	**0.01 U**
	OF-716	06/25/02	0.5 J	0.002 J	**0.1 U**	0.002 U	0.35 UJ	0.06 UJ	0.3 J	0.01 UJ	1.1	**0.01 U**
		11/05/02[b]	0.51 J	0.003 J	**0.1 U**	0.005 J	0.27 J	0.031 U	0.49	0.01 U	1.2 J	**0.01 U**
		06/16/03	0.64 J	0.003 UJ	**0.1 U**	0.003 J	0.46	0.05	0.59	0.01 U	1.3	**0.01 U**
		06/30/04	0.56 J	0.002 UJ	0.04 U	0.001 U	0.29	0.009 U	0.56	0.005 U	0.62	**0.01 U**
		11/15/04	0.49 J	0.001 U	0.06 U	0.001 U	0.76	0.021	0.59	0.005 U	1.38	**0.01 U**
		07/19/05	0.46 J	0.0011 J	0.08 U	0.02 U	0.3	0.009 J	0.69	0.002 U	1.09	**0.1**
		08/07/06	0.57 J	0.0029 J	0.02 U	0.0008 U	0.23	0.017 J	0.63	0.048 U	1.06	**0.01**
		07/31/07	1.02	0.003 U	0.03 U	0.02 U	1.34	0.048 U	0.79	0.02 U	1.79 J	**0.005 J**
		07/31/08	0.7 U	0.04 U	0.05 U	0.017 J	0.58	0.023	2.51	0.009	2.91	**0.002 J**
		07/06/09	1.06	0.020 U	**0.2 U**	0.02 U	0.76	0.030 U	1.05	0.030 U	1.68 U	**0.01 U**
103	SP-703	06/16/03	0.37 J	0.004 J	**0.19 U**	0.017 J	0.19	0.04	0.97	0.008 U	0.7	**0.01 U**
		07/01/04	0.32 J	0.001 UJ	0.04 U	0.001 U	0.12	0.013 J	1.14	0.005 U	0.17 J	**0.01 U**
		11/15/04	0.27 J	0.002 U	0.06 U	0.01 J	0.17	0.049	1.17	0.005 U	0.34 J	**0.01 U**
		07/20/05	0.6 J	0.008 U	0.08 U	0.004 U	0.43 J	0.026 J	2.35	0.004 U	0.34 J	**0.05**
		08/07/06	0.51	0.02 U	0.02 U	0.003 U	0.24	0.014 J	1.23	0.004 U	5.3 J	**0.01 U**
		07/31/07	0.38 J	0.003 U	0.03 U	0.02 U	0.26	0.043 U	1.31	0.003 U	1.24 UJ	**0.01 U**
		07/30/08	0.7 U	0.04 U	0.05 U	0.009 J	0.34	0.02 J	2.98	0.009 U	1.43 U	**0.01 U**
		07/07/09	0.44 J	0.020 U	**0.2 U**	0.02 U	0.23 U	0.030 UJ	1.67	0.030 U	0.53 U	**0.01 U**
	OF-705	06/25/02	0.34 UJ	0.003 J	**0.1 U**	0.005 J	0.35 UJ	0.031 UJ	0.6 J	0.01 UJ	4.3	**0.01**
		11/06/02	0.58 J	0.003 J	**0.1 U**	0.004	1.53 J	0.066 U	1.37	0.02 U	10.7 J	**0.01 U**
		06/16/03	0.43 J	0.004 J	**0.1 U**	0.011 J	0.22	0.04	1.19	0.008 U	4.4	**0.01 U**
		07/01/04	0.75 J	0.002 UJ	0.04 U	0.002 U	0.53	0.009 U	2.15	0.005 U	9.31	**0.01 U**
		11/15/04	0.97 J	0.003 U	0.06 U	0.004 U	1.9	0.064	1.43	0.005 U	15.2	**0.01 U**
		07/20/05	0.56 J	0.0018 J	0.08 U	0.02 U	0.625	0.008 U	1.22	0.002 J	5	**0.03**
		08/07/06	0.61 J	0.0037 J	0.02 U	0.0008 U	0.45	0.02	1.16	0.063 U	4.94	**0.01 U**
		07/30/07	1.72	0.003 U	0.03 U	0.02 U	0.76	0.556	1.03	0.02 U	5.42 J	**0.01 U**

Table 6-5 (Continued)
Summary of Analytical Results for Metals and Cyanide in Seeps and Outfalls From November 2002 Through July 2009

Site	Location	Sampling Date	Total Metals (µg/L)				Dissolved Metals (µg/L)					Cyanide (mg/L)
			Arsenic	Beryllium	Mercury	Thallium	Copper	Lead	Nickel	Silver	Zinc	
		07/31/08	1.1 J	0.04 U	0.05 U	0.005 U	3.65	0.036	**10.5**	0.052 U	10.8	**0.01 U**
		07/07/09	2.61	0.020 U	**0.2 U**	0.02 U	0.81	0.046 U	1.94	0.030 U	7.18	**0.01 U**
	SP-707[c]	06/25/02	1.03 J	0.046	**0.1 U**	0.067	0.37 UJ	0.047 UJ	1.8 J	0.03 UJ	13.3	**0.01 U**
		11/06/02	2.46 J	**0.097 J**	**0.2**	0.043	0.4 J	0.023 U	1.62	0.03 U	1.4 J	**0.01 U**
		06/16/03	**4.05 J**	**0.083 J**	**0.61 U**	0.031	0.79	0.03	1.09	0.075	0.8	**0.01 U**
		06/29/04	2.45 J	0.034 J	0.04 U	0.007 J	0.291	0.124	1.32	0.031	0.65	**0.01 U**
		11/16/04	1.54 J	0.016 J	0.06 U	0.005 U	0.57	0.009 U	2.03	0.005 U	2.72	**0.01 U**
		07/19/05	1.4 J	0.0339	**0.2 U**	0.0197 J	1.35	0.036	2.68	0.008 J	6.78	**0.03**
		08/08/06	1.28 J	0.0039 J	0.02 U	0.0143 J	0.28	0.033	1.28	0.055 U	0.52	**0.01 U**

[a]No sample was collected from this location in summer 2002 and 2003 because of insufficient flow, and from summer 2005 to 2009 because salinity was greater than 1%, indicating the water was not representative of groundwater.
[b]Data from these locations and dates were obtained from the Naval Installation Restoration Information Solution (NIRIS) database and not the fall 2002 long-term monitoring report (U.S. Navy 2003d). Analytical results from these two sources were not consistent. Based on a review of the chain-of-custody forms, the values in NIRIS appear to be correct.
[c]No sample was collected from this location in 2007, 2008, and 2009 because salinity was greater than 1%, indicating the water was not representative of groundwater.

Notes:
Bolded value indicates it exceeds or is equal to the remediation goal.
J - The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
MDL - method detection limit
MRL - method reporting limit
µg/L - microgram per liter
mg/L - milligram per liter
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.
UJ - The compound was undetected, and the detection limit is estimated.

Table 6-6
Total Metals Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	Antimony (mg/kg)[a]	Arsenic (mg/kg)	Vanadium (mg/kg)[a]
Clam Tissue						
CLAM01	13700	06-24-2002	ES	0.02 U	10.1 J	1
	19065	07-01-2004	ES	0.009 UJ	13.8	0.7 UJ
	CLAM1_052709	05-27-2009	ES	0.1 U	13.2	1 U
CLAM02	13701	06-24-2002	ES	0.02 U	20.5 J	0.8 J
	13702	06-24-2002	FD	0.02 U	15.8 J	0.8 J
	19064	07-01-2004	ES	0.014 UJ	18.5	0.7 UJ
	CLAM2_052709	05-27-2009	ES	0.1 U	24.6	1 U
CLAM03	13703	06-24-2002	ES	0.02 U	16.2 J	0.9 J
	19063	07-01-2004	ES	0.012 UJ	20.5	0.7 UJ
	CLAM3_052709	05-27-2009	ES	0.1 U	17.5	1 U
CLAM04	13704	06-24-2002	ES	0.02 U	19.8 J	0.7 J
	19062	07-01-2004	ES	0.012 UJ	24.2	0.7 UJ
	CLAM4_052709	05-27-2009	ES	0.1 U	15.6	1 U
CLAM05	13705	06-24-2002	ES	0.02 U	21.4 J	0.8 J
	19061	07-01-2004	ES	0.016 UJ	29	0.7 UJ
	CLAM5_052709	05-27-2009	ES	0.1 U	21.1	1 U
CLAM06	13706	06-24-2002	ES	0.02 U	15.3 J	0.8 J
	19060	06-30-2004	ES	0.014 UJ	20.6	0.7 UJ
	CLAM6_052709	05-27-2009	ES	0.1 U	18.3	1 U
	CLAMDUP2_052709	05-27-2009	FD	0.1 U	14.8	1 U
CLAM07	13707	06-24-2002	ES	0.02 U	11.2 J	0.7 J
	19059	06-30-2004	ES	0.009 UJ	11.5	0.7 UJ
	CLAM7_052709	05-27-2009	ES	0.1 U	12.6	1 U
CLAM08	13708	06-24-2002	ES	0.02 U	17.2 J	0.9 J
	19058	06-30-2004	ES	0.014 UJ	23.8	0.7 UJ
	CLAM8_052609	05-26-2009	ES	0.1 U	20.5	1 U
CLAM09	13709	06-24-2002	ES	0.02 U	19.7 J	0.7 J
	19057	06-30-2004	ES	0.01 UJ	24.9	0.7 UJ
	CLAM9_052609	05-26-2009	ES	0.1 U	17	1 U
CLAM10	13710	06-24-2002	ES	0.02 U	19.8 J	0.9 J
	19056	06-30-2004	ES	0.01 UJ	25.2	0.7 UJ
	CLAM10_052609	05-26-2009	ES	0.1 U	21.6	1 U
CLAM11	13711	06-24-2002	ES	0.02 U	19.9 J	0.8 J
	19055	6/30/2004	ES	0.012 UJ	21.1	0.7 UJ
	CLAM11_052609	05-26-2009	ES	0.1 U	21.9	1 U
	CLAMDUP1_052609	05-26-2009	FD	0.1 U	21.4	1 U

Table 6-6 (Continued)
Total Metals Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	Antimony (mg/kg)[a]	Arsenic (mg/kg)	Vanadium (mg/kg)[a]
CLAM12	13712	06-25-2002	ES	0.02 U	33.9	0.6 U
	19054	06-30-2004	ES	0.017 UJ	37.4	0.7 UJ
	CLAM12_052609	05-26-2009	ES	0.1 U	23.8	1 U
CLAM13	13713	06-25-2002	ES	0.02 U	35.6	0.6 U
	19050	06-30-2004	ES	0.017 UJ	33.3	0.7 UJ
	CLAM13_052609	05-26-2009	ES	0.1 U	17.5	1 U
CLAM14	13714	06-25-2002	ES	0.02 U	29.6	0.6 J
	19051	06-30-2004	ES	0.013 UJ	26.7	0.7 J
	CLAM14_052609	05-26-2009	ES	0.1 U	19.4	1 U
CLAM15	13715	06-25-2002	ES	0.02 U	22.8	0.6 U
	19052	06-30-2004	ES	0.017 UJ	31.9	0.7 J
	19053	06-30-2004	FD	0.015 UJ	28.1	0.7 J
	CLAM15_052609	05-26-2009	ES	0.1 U	22.3	1 U
CLAM16	13729	06-26-2002	ES	0.02 U	14.5	0.6 U
	19067	07-02-2004	ES	0.005 UJ	14.1	0.7 UJ
	CLAM16_052809	05-28-2009	ES	0.1 U	15.1	1 U
CLAM17	13730	06-26-2002	ES	0.02 U	13.8	0.6 U
	19068	07-02-2004	ES	0.012 UJ	24	0.7 UJ
	CLAM17_052809	05-28-2009	ES	0.1 U	19.9	1 U
	CLAMDUP3_052809	05-28-2009	FD	0.1 U	16.8	1 U
CLAM18	13731	06-26-2002	ES	0.02 U	15.4	0.7 J
	19066	07-02-2004	ES	0.011 UJ	17.3	0.7 UJ
	CLAM18_052809	05-28-2009	ES	0.1 U	13.8	1 U
Crab Tissue						
CRAB01	13738	07-16-2002	ES	0.02 U	64.1	0.4 J
	19083	07-13-2004	ES	0.007 UJ	29.4 J	0.4 UJ
	CRAB1_060109	06-01-2009	ES	0.1 U	67.3	1 U
CRAB02	13739	07-16-2002	ES	0.02 U	53.7	0.3 J
	19070	07-13-2004	ES	0.006 UJ	46.6 J	0.4 UJ
	CRAB2_060109	06-01-2009	ES	0.1 U	54	1 U
CRAB03	13740	07-16-2002	ES	0.02 U	53.2	0.5 J
	13741	07-16-2002	FD	0.02 U	46.1	0.4 J
	13742	07-16-2002	FD	0.02 U	55.9	0.6 J
	19079	07-13-2004	ES	0.005 UJ	37.9 J	0.4 UJ
	19080	07-13-2004	FD	0.006 UJ	66.4 J	0.4 UJ
	CRAB3_060109	06-01-2009	ES	0.1 U	43.9	1 U
	CRABDUP1_060109	06-01-2009	FD	0.1 U	44.4	1 U
	CRABTRP1_060109	06-01-2009	FD	0.1 U	54.7	1 U

Table 6-6 (Continued)
Total Metals Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	Antimony (mg/kg)[a]	Arsenic (mg/kg)	Vanadium (mg/kg)[a]
CRAB04 *(C. gracilis)*	13743	07-16-2002	ES	0.02 U	28.5	0.5 J
	13744	07-16-2002	FD	0.02 U	55.7	0.6 J
	19081	07-13-2004	ES	0.005 UJ	37.3 J	0.4 UJ
CRAB04 *(C. productus)*	CRAB4_060109	06-01-2009	ES	0.1 U	65.4	1 U
	CRAB4A_060109	06-01-2009	FD	0.1 U	98.4	1 U
CRAB05	13745	07-16-2002	ES	0.02 U	43	0.6 J
	13746	07-16-2002	FD	0.02 U	46.5	0.6 J
	19071	07-13-2004	ES	0.005 UJ	44.8 J	0.4 UJ
	19072	07-13-2004	FD	0.007 UJ	49.8 J	0.4 UJ
	CRAB5_060109	06-01-2009	ES	0.1 U	55.9	1 U
CRAB06	13747	07-16-2002	ES	0.02 U	23.4	0.5 J
	13748	07-16-2002	FD	0.02 U	30.3	0.5 J
	19076	07-13-2004	ES	0.006 UJ	38.5 J	0.4 UJ
	19077	07-13-2004	FD	0.005 UJ	33.1 J	0.4 UJ
	19078	07-13-2004	FD	0.005 UJ	36.2 J	0.4 UJ
	CRAB6_060109	06-01-2009	ES	0.1 U	33.7	1 U
CRAB07	13749	07-16-2002	ES	0.02 U	42.1	0.4 J
	19073	07-13-2004	ES	0.008 UJ	41.5 J	0.4 UJ
	CRAB7_060109	06-01-2009	ES	0.1 U	63.5	1 U
CRAB08	13750	07-16-2002	ES	0.02 U	49	0.6 J
	19074	07-13-2004	ES	0.006 UJ	28.4 J	0.4 UJ
	CRAB8_060209	06-02-2009	ES	0.1 U	42.7	1 U
CRAB09	13751	07-16-2002	ES	0.02 U	45.3	0.6 J
	19082	07-13-2004	ES	0.006 UJ	34.3	0.4 UJ
	19084	07-13-2004	FD	0.007 UJ	35 J	0.4 UJ
	CRAB9_060209	06-02-2009	ES	0.1 U	49.5	1 U
CRAB10	13752	07-16-2002	ES	0.02 U	33.9	0.6 J
	19075	07-13-2004	ES	0.009 UJ	42.5 J	0.4 UJ
	CRAB10_060209	06-02-2009	ES	0.1 U	38	1 U
	CRABDUP3_060209	06-02-2009	ES	0.1 U	40.4	1 U
CRAB11	13753	07-17-2002	ES	0.02 U	26.8	0.6 J
	19085	07-14-2004	ES	0.007 UJ	34.6 J	0.4 UJ

Table 6-6 (Continued)
Total Metals Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	Antimony (mg/kg)[a]	Arsenic (mg/kg)	Vanadium (mg/kg)[a]
CRAB12	13754	07-17-2002	ES	0.02 U	45.8	0.8 J
	19086	07-14-2004	ES	0.01 UJ	39.1 J	0.4 UJ
	CRAB12_060209	06-02-2009	ES	0.1 U	50.9	1 U
	CRABDUP2_060209	06-02-2009	FD	0.1 U	22.4	1 U
CRAB13	13755	07-17-2002	ES	0.02 U	43.2	0.4 J
	19087	07-14-2004	ES	0.009 UJ	42 J	0.4 UJ
CRAB17	CRAB17_060309	06-03-2009	ES	0.1 U	42.3	1 U
CRAB18	CRAB18_060309	06-03-2009	ES	0.1 U	34.8	1 U
	CRABDUP4_060309	06-03-2009	FD	0.1 U	33.2	1 U
CRAB19	CRAB19_060309	06-03-2009	ES	0.1 U	39.8	1 U

[a]Undetected 2009 results are the wet-weight method detection limit.

Notes:
ES - environmental sample
FD - field duplicate
J - estimated value
mg/kg - milligram per kilogram (dry weight)
U - not detected above the reporting limit

Table 6-7
Semivolatile Organic Compound Concentrations in OU 1 Marine Tissue
(2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	3,3'-Dichlorobenzidine (mg/kg)	Pentachlorophenol (mg/kg)
Clam Tissue					
CLAM01	13700	06-24-2002	ES	0.11 U	0.09 U
	19065	07-01-2004	ES	0.8 U	0.091 U
	CLAM1_052709	05-27-2009	ES	1 U	2 U
CLAM02	13701	06-24-2002	ES	0.11 U	0.09 U
	13702	06-24-2002	FD	0.11 U	0.09 U
	19064	07-01-2004	ES	0.8 U	0.091 U
	CLAM2_052709	05-27-2009	ES	0.96 U	1.9 U
CLAM03	13703	06-24-2002	ES	0.11 U	0.09 U
	19063	07-01-2004	ES	0.8 U	0.091 U
	CLAM3_052709	05-27-2009	ES	0.93 U	1.9 U
CLAM04	13704	06-24-2002	ES	0.11 R	0.09 U
	19062	07-01-2004	ES	0.8 U	0.091 U
	CLAM4_052709	05-27-2009	ES	1 U	2 U
CLAM05	13705	06-24-2002	ES	0.11 U	0.09 U
	19061	07-01-2004	ES	0.8 U	0.091 U
	CLAM5_052709	05-27-2009	ES	1 U	2 U
CLAM06	13706	06-24-2002	ES	0.11 U	0.09 U
	19060	06-30-2004	ES	0.8 UJ	0.091 U
	CLAM6_052709	05-27-2009	ES	0.91 U	1.8 U
	CLAMDUP2_052709	05-27-2009	FD	1 U	2.1 U
CLAM07	13707	06-24-2002	ES	0.11 U	0.09 U
	19059	06-30-2004	ES	0.8 U	0.091 U
	CLAM7_052709	05-27-2009	ES	1 U	2 U
CLAM08	13708	06-24-2002	ES	0.11 U	0.09 U
	19058	06-30-2004	ES	0.8 U	0.091 U
	CLAM8_052609	05-26-2009	ES	1.1 U	2.1 U
CLAM09	13709	06-24-2002	ES	0.11 U	0.09 U
	19057	06-30-2004	ES	0.8 U	0.091 U
	CLAM9_052609	05-26-2009	ES	1 U	2.1 U
CLAM10	13710	06-24-2002	ES	0.11 U	0.09 U
	19056	06-30-2004	ES	0.8 U	0.091 U
	CLAM10_052609	05-26-2009	ES	0.92 U	1.8 U
CLAM11	13711	06-24-2002	ES	0.11 U	0.09 U
	19055	06-30-2004	ES	0.8 U	0.091 U
	CLAM11_052609	05-26-2009	ES	1 U	2 U
	CLAMDUP1_052609	05-26-2009	FD	1 U	2.1 U

Table 6-7 (Continued)
Semivolatile Organic Compound Concentrations in OU 1 Marine Tissue
(2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	3,3'-Dichlorobenzidine (mg/kg)	Pentachlorophenol (mg/kg)
CLAM12	13712	06-25-2002	ES	0.11 U	0.09 U
	19054	06-30-2004	ES	0.8 U	0.091 U
	CLAM12_052609	05-26-2009	ES	1.1 U	2.2 U
CLAM13	13713	06-25-2002	ES	0.11 U	0.09 U
	19050	06-30-2004	ES	0.8 U	0.091 U
	CLAM13_052609	05-26-2009	ES	0.94 U	1.9 U
CLAM14	13714	06-25-2002	ES	0.11 U	0.09 U
	19051	06-30-2004	ES	0.8 U	0.091 U
	CLAM14_052609	05-26-2009	ES	1.1 U	2.2 U
CLAM15	13715	06-25-2002	ES	0.11 U	0.09 U
	19052	06-30-2004	ES	0.8 U	0.091 U
	19053	06-30-2004	FD	0.8 U	0.091 U
	CLAM15_052609	05-26-2009	ES	0.92 U	1.8 U
CLAM16	13729	06-26-2002	ES	0.11 U	0.09 U
	CLAM16_052809	05-28-2009	ES	0.98 U	2 U
CLAM17	13730	06-26-2002	ES	0.11 U	0.09 U
	CLAM17_052809	05-28-2009	ES	0.97 U	1.9 U
	CLAMDUP3_052809	05-28-2009	FD	1 U	2 U
CLAM18	13731	06-26-2002	ES	0.11 U	0.09 U
	CLAM18_052809	05-28-2009	ES	1.1 U	2.2 U
Crab Tissue					
CRAB01	13738	07-16-2002	FD	0.11 U	0.09 U
	19083	07-13-2004	ES	0.8 U	0.091 U
	CRAB1_060109	06-01-2009	ES	0.95 U	1.9 U
CRAB02	13739	07-16-2002	ES	0.11 U	0.09 U
	19070	07-13-2004	ES	0.8 U	0.091 U
	CRAB2_060109	06-01-2009	ES	1 U	2.1 U
CRAB03	13740	07-16-2002	ES	0.11 U	0.09 U
	13741	07-16-2002	FD	0.11 U	0.09 U
	13742	07-16-2002	FD	0.11 U	0.09 U
	19079	07-13-2004	ES	0.8 U	0.091 U
	19080	07-13-2004	FD	0.8 U	0.091 U
	CRAB3_060109	06-01-2009	ES	1.1 U	2.2 U
	CRABDUP1_060109	06-01-2009	FD	1 U	2 U
	CRABTRP1_060109	06-01-2009	FD	0.95 U	1.9 U

Table 6-7 (Continued)
Semivolatile Organic Compound Concentrations in OU 1 Marine Tissue
(2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	3,3'-Dichlorobenzidine (mg/kg)	Pentachlorophenol (mg/kg)
CRAB04 *(C. gracilis)*	13743	07-16-2002	ES	0.11 U	0.09 U
	13744	07-16-2002	FD	0.11 U	0.09 U
	19081	07-13-2004	ES	0.8 U	0.091 U
CRAB04 *(C. productus)*	CRAB4_060109	06-01-2009	ES	1.1 U	2.2 U
	CRAB4A_060109	06-01-2009	FD	1 U	2 U
CRAB05	13745	07-16-2002	ES	0.11 U	0.09 U
	13746	07-16-2002	FD	0.11 U	0.09 U
	19071	07-13-2004	ES	0.8 U	0.091 U
	19072	07-13-2004	FD	0.8 U	0.091 U
	CRAB5_060109	06-01-2009	ES	1.1 U	2.2 U
CRAB06	13747	07-16-2002	ES	0.11 U	0.09 U
	13748	07-16-2002	FD	0.11 U	0.09 U
	19076	07-13-2004	ES	0.8 U	0.091 U
	19077	07-13-2004	FD	0.8 U	0.091 U
	19078	07-13-2004	FD	0.8 U	0.091 U
	CRAB6_060109	06-01-2009	ES	1.1 U	2.1 U
CRAB07	13749	07-16-2002	ES	0.11 U	0.09 U
	19073	07-13-2004	ES	0.8 U	0.091 U
	CRAB7_060109	06-01-2009	ES	1 U	2 U
CRAB08	13750	07-16-2002	ES	0.11 U	0.09 U
	19074	07-13-2004	ES	0.8 U	0.091 U
	CRAB8_060209	06-02-2009	ES	1 U	2 U
CRAB09	13751	07-16-2002	ES	0.11 U	0.09 U
	19082	07-13-2004	ES	0.8 U	0.091 U
	19084	07-13-2004	FD	0.8 U	0.091 U
	CRAB9_060209	06-02-2009	ES	1.1 U	2.2 U
CRAB10	13752	07-16-2002	ES	0.11 U	0.09 U
	19075	07-13-2004	ES	0.8 U	0.091 U
	CRAB10_060209	06-02-2009	ES	0.98 U	2 U
	CRABDUP3_060209	06-02-2009	ES	1 U	2 U
CRAB11	13753	07-17-2002	ES	0.11 U	0.09 U
	19085	07-14-2004	ES	0.8 U	0.091 U
CRAB12 *(C. gracilis)*	13754	07-17-2002	ES	0.11 U	0.09 U
	19086	07-14-2004	ES	0.8 U	0.091 U
CRAB12 *(C. productus)*	CRAB12_060209	06-02-2009	ES	1 U	2 U
	CRABDUP2_060209	06-02-2009	FD	0.97 U	1.9 U
CRAB13	13755	07-17-2002	ES	0.11 U	0.09 U
	19087	07-14-2004	ES	0.8 UJ	0.091 U

Table 6-7 (Continued)
Semivolatile Organic Compound Concentrations in OU 1 Marine Tissue
(2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	3,3'-Dichlorobenzidine (mg/kg)	Pentachlorophenol (mg/kg)
CRAB17	CRAB17_060309	06-03-2009	ES	0.97 U	1.9 U
CRAB18	CRAB18_060309	06-03-2009	ES	0.98 U	2 U
	CRABDUP4_060309	06-03-2009	FD	0.99 U	2 U
CRAB19	CRAB19_060309	06-03-2009	ES	0.98 U	2 U

Notes:
ES - environmental sample
FD - field duplicate
J - estimated value
mg/kg - milligram per kilogram (wet weight)
U - not detected above the reporting limit

Table 6-8
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	4-Amino-2,6-Dinitrotoluene (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)
Clam Tissue									
CLAM01	13700	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.21 J	0.11 U	0.1 U
	19065	07-01-2004	ES	0.09 U	0.092 UJ	0.069 U	0.1 U	0.14 U	0.25 UJ
	CLAM1_052709	05-27-2009	ES	0.02 U	0.077 NJ	0.02 U	0.02 U	0.04 U	0.05 U
CLAM02	13701	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.13 J	0.11 U	0.1 U
	13702	06-24-2002	FD	0.077 U	0.06 U	0.06 U	0.12 J	0.46 J	0.1 U
	19064	07-01-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.26 J	0.25 U
	CLAM2_052709	05-27-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM03	13703	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.21 J	0.11 U	0.1 U
	19063	07-01-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM3_052709	05-27-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM04	13704	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19062	07-01-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM4_052709	05-27-2009	ES	0.02 U	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U
CLAM05	13705	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.23 J	0.11 U	0.1 U
	19061	07-01-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM5_052709	05-27-2009	ES	0.02 U	0.029 U	7.8 J	0.02 U	0.039 U	0.049 U
CLAM06	13706	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.28 J	0.11 U	0.1 U
	19060	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.28 J	0.25 U
	CLAM6_052709	05-27-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 R	0.05 R
	CLAMDUP2_052709	05-27-2009	FD	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM07	13707	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.19 J	0.11 U	0.1 U
	19059	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM7_052709	05-27-2009	ES	0.02 U	0.03 U	7.3 J	0.02 U	0.04 U	0.05 U
CLAM08	13708	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19058	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM8_052609	05-26-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM09	13709	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19057	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM9_052609	05-26-2009	ES	0.02 U	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	1,3-Dinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)	2-Amino-4,6-Dinitrotoluene (mg/kg)	2-Nitrotoluene (mg/kg)	3-Nitrotoluene (mg/kg)	4-Nitrotoluene (mg/kg)	HMX (mg/kg)	Nitrobenzene (mg/kg)
CLAM01	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CLAM02	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CLAM03	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CLAM04	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U
CLAM05	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U
CLAM06	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CLAM07	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CLAM08	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CLAM09	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	4-Amino-2,6-Dinitrotoluene (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)
CLAM10	13710	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19056	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM10_052609	05-26-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM11	13711	06-24-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19055	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.18 J	0.25 U
	CLAM11_052609	05-26-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CLAMDUP1_052609	05-26-2009	FD	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM12	13712	06-25-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.13 J	0.1 UJ
	19054	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM12_052609	05-26-2009	ES	0.05 NJ	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U
CLAM13	13713	06-25-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19050	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM13_052609	05-26-2009	ES	0.047 NJ	0.13 NJ	0.02 U	0.02 U	0.04 U	0.05 U
CLAM14	13714	06-25-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19051	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM14_052609	05-26-2009	ES	0.053 NJ	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM15	13715	06-25-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19052	06-30-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	19053	06-30-2004	FD	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CLAM15_052609	05-26-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 R	0.05 R
CLAM16	13729	06-26-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	CLAM16_052809	05-28-2009	ES	0.02 U	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U
CLAM17	13730	06-26-2002	ES	0.077 U	0.06 U	0.06 U	0.12 J	0.11 U	0.1 U
	CLAM17_052809	05-28-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CLAMDUP3_052809	05-28-2009	FD	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CLAM18	13731	06-26-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	CLAM18_052809	05-28-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	1,3-Dinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)	2-Amino-4,6-Dinitrotoluene (mg/kg)	2-Nitrotoluene (mg/kg)	3-Nitrotoluene (mg/kg)	4-Nitrotoluene (mg/kg)	HMX (mg/kg)	Nitrobenzene (mg/kg)
CLAM10	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CLAM11	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CLAM12	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U
CLAM13	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CLAM14	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CLAM15	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CLAM16	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U
CLAM17	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CLAM18	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	4-Amino-2,6-Dinitrotoluene (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)
Crab Tissue									
CRAB01	13738	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19083	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB1_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB02	13739	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19070	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB2_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB03	13740	07-16-2002	ES	0.077 U	0.06 U	0.083 NJ	0.061 U	0.11 U	0.1 U
	13741	07-16-2002	FD	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	13742	07-16-2002	FD	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19079	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	19080	07-13-2004	FD	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB3_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CRABDUP1_060109	06-01-2009	FD	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CRABTRP1_060109	06-01-2009	FD	0.02 U	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U
CRAB04	13743	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	13744	07-16-2002	FD	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19081	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB4_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CRAB4A_060109	06-01-2009	FD	0.02 U	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U
CRAB05	13745	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	13746	07-16-2002	FD	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19071	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	19072	07-13-2004	FD	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB5_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB06	13747	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	13748	07-16-2002	FD	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19076	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	19077	07-13-2004	FD	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	19078	07-13-2004	FD	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB6_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	1,3-Dinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene mg/kg)	2-Amino-4,6-Dinitrotoluene (mg/kg)	2-Nitrotoluene (mg/kg)	3-Nitrotoluene (mg/kg)	4-Nitrotoluene (mg/kg)	HMX (mg/kg)	Nitrobenzene (mg/kg)
CRAB01	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CRAB02	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CRAB03	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U
CRAB04	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U
CRAB05	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CRAB06	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	Sample ID	Sample Date	Sample Type	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	4-Amino-2,6-Dinitrotoluene (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)
CRAB07	13749	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19073	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB7_060109	06-01-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB08	13750	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19074	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB8_060209	06-02-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB09	13751	07-16-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19082	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	19084	07-13-2004	FD	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB9_060209	06-02-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB10	13752	07-16-2002	ES	0.16 U	0.12 U	0.12 U	0.13 U	0.22 U	0.2 U
	19075	07-13-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB10_060209	06-02-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CRABDUP3_060209	06-02-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB11	13753	07-17-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19085	07-14-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 UJ
CRAB12	13754	07-17-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19086	07-14-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
	CRAB12_060209	06-02-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CRABDUP2_060209	06-02-2009	FD	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.086 NJ
CRAB13	13755	07-17-2002	ES	0.077 U	0.06 U	0.06 U	0.061 U	0.11 U	0.1 U
	19087	07-14-2004	ES	0.09 U	0.092 U	0.069 U	0.1 U	0.14 U	0.25 U
CRAB17	CRAB17_060309	06-03-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB18	CRAB18_060309	06-03-2009	ES	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
	CRABDUP4_060309	06-03-2009	FD	0.02 U	0.03 U	0.02 U	0.02 U	0.04 U	0.05 U
CRAB19	CRAB19_060309	06-03-2009	ES	0.02 U	0.029 U	0.02 U	0.02 U	0.039 U	0.049 U

Table 6-8 (Continued)
Ordnance Compound Concentrations in OU 1 Marine Tissue (2002 Through 2009)

Location	1,3-Dinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)	2-Amino-4,6-Dinitrotoluene (mg/kg)	2-Nitrotoluene (mg/kg)	3-Nitrotoluene (mg/kg)	4-Nitrotoluene (mg/kg)	HMX (mg/kg)	Nitrobenzene (mg/kg)
CRAB07	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CRAB08	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
CRAB09	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CRAB10	0.11 U	0.15 U	0.15 U	0.22 U	0.16 U	0.32 U	0.18 U	0.22 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.081 U	0.071 U	0.081 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CRAB11	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
CRAB12	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
	0.05 U	0.02 U	0.1 U	0.08 U	0.07 U	0.08 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CRAB13	0.051 U	0.074 U	0.071 U	0.11 U	0.077 U	0.16 U	0.09 U	0.11 U
	0.068 U	0.1 U	0.11 U	0.17 U	0.12 U	0.17 U	0.22 U	0.071 U
CRAB17	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CRAB18	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
	0.05 U	0.02 U	0.099 U	0.079 U	0.069 U	0.079 U	0.03 U	0.05 U
CRAB19	0.049 U	0.02 U	0.098 U	0.078 U	0.069 U	0.078 U	0.029 U	0.049 U

Notes:
ES - environmental sample
FD - field duplicate
HMX - octahydro-1,3,5,7,-tetranitro-1,3,5,7-tetrazocine
J - estimated value
mg/kg - milligram per kilogram (wet weight)
RDX - royal demolition explosive (cyclotrimethylene trinitramine)
U - not detected above the reporting limit

Table 6-9
Concentrations of Arsenic Species in 2009 OU 1 Marine Tissue

Location	Sample ID	Sample Date	Sample Type	Total Arsenic (mg/kg)	Arsenic(V) (mg/kg)	Arsenic(III) (mg/kg)	Inorganic Arsenic (mg/kg)	Organic Arsenic (mg/kg)
CLAM01	CLAM1_052709	05-27-2009	ES	2.9	0.009 J	0.027	0.036	2.8
CLAM02	CLAM2_052709	05-27-2009	ES	5.1	0.013	0.015	0.028	5.1
CLAM03	CLAM3_052709	05-27-2009	ES	4	0.016	0.022	0.037	4
CLAM04	CLAM4_052709	05-27-2009	ES	3.4	0.0039 J	0.016	0.019	3.4
CLAM05	CLAM5_052709	05-27-2009	ES	4.6	0.0062 J	0.031	0.037	4.6
CLAM06	CLAM6_052709	05-27-2009	ES	5.3 J	0.014 J	0.03 J	0.044 J	5.3 J
	CLAMDUP2_052709	05-27-2009	FD	4.4	0.028	0.016	0.044	4.4
CLAM07	CLAM7_052709	05-27-2009	ES	3.3	0.034	0.019	0.053	3.2
CLAM08	CLAM8_052609	05-26-2009	ES	3.5	0.013 J	0.018	0.031	3.4
CLAM09	CLAM9_052609	05-26-2009	ES	4.1	0.0096 J	0.019	0.029	4.1
CLAM10	CLAM10_052609	05-26-2009	ES	3.6	0.0047 U	0.05	0.04	3.5
CLAM11	CLAM11_052609	05-26-2009	ES	4.3	0.035	0.0074 J	0.043	4.3
	CLAMDUP1_052609	05-26-2009	FD	4.1	0.0048 U	0.046	0.042	4
CLAM12	CLAM12_052609	05-26-2009	ES	5.1	0.0076 J	0.04	0.047	5.1
CLAM13	CLAM13_052609	05-26-2009	ES	5.5	0.013 J	0.048	0.061	5.4
CLAM14	CLAM14_052609	05-26-2009	ES	5.8	0.015	0.033	0.048	5.8
CLAM15	CLAM15_052609	05-26-2009	ES	4.1	0.0038 U	0.051	0.051	4.1
CLAM16	CLAM16_052809	05-28-2009	ES	3.6	0.0038 U	0.013 J	0.013	3.6
CLAM17	CLAM17_052809	05-28-2009	ES	4.2	0.0055 U	0.011 J	0.015	4.2
	CLAMDUP3_052809	05-28-2009	FD	4.3	0.0051 U	0.015	0.018	4.3
CLAM18	CLAM18_052809	05-28-2009	ES	4.1	0.017	0.015	0.032	4.1
Crab Tissue								
CRAB01	CRAB1_060109	06-01-2009	ES	14.7	0.0083 J	0.015	0.023	14.6
CRAB02	CRAB2_060109	06-01-2009	ES	11.5	0.011 J	0.018	0.029	11.5
CRAB03	CRAB3_060109	06-01-2009	ES	10.4	0.013 J	0.012 J	0.025	10.4

Table 6-9 (Continued)
Concentrations of Arsenic Species in 2009 OU 1 Marine Tissue

Location	Sample ID	Sample Date	Sample Type	Total Arsenic (mg/kg)	Arsenic(V) (mg/kg)	Arsenic(III) (mg/kg)	Inorganic Arsenic (mg/kg)	Organic Arsenic (mg/kg)
CRAB03	CRABDUP1_060109	06-01-2009	FD	10.6	0.014 J	0.019	0.033	10.5
CRAB03	CRABTRP1_060109	06-01-2009	FD	11.1	0.007 J	0.018	0.025	11.1
CRAB04	CRAB4_060109	06-01-2009	ES	13.3	0.0054 J	0.011 J	0.017	13.3
(C. productus)	CRAB4A_060109	06-01-2009	FD	26	0.0096 J	0.0094 J	0.019	26.1
CRAB05	CRAB5_060109	06-01-2009	ES	10.6	0.017	0.015 J	0.032	10.6
CRAB06	CRAB6_060109	06-01-2009	ES	6.5	0.0072 J	0.012 J	0.02	6.4
CRAB07	CRAB7_060109	06-01-2009	ES	11.4	0.0093 J	0.013 J	0.023	11.4
CRAB08	CRAB8_060209	06-02-2009	ES	7.24	0.014 J	0.019	0.033	7.2
CRAB09	CRAB9_060209	06-02-2009	ES	10.2	0.0087 J	0.016	0.024	10.2
CRAB10	CRAB10_060209	06-02-2009	ES	9.3	0.0042 U	0.016	0.017	9.2
	CRABDUP3_060209	06-02-2009	ES	10.6	0.016	0.028	0.045	10.6
CRAB12	CRAB12_060209	06-02-2009	ES	11.1	0.016	0.011 J	0.027	11.1
(C. productus)	CRABDUP2_060209	06-02-2009	FD	4.9	0.0045 U	0.005 U	0.004 J	4.9
CRAB17	CRAB17_060309	06-03-2009	ES	9.2	0.014 J	0.022	0.037	9.1
CRAB18	CRAB18_060309	06-03-2009	ES	9.5	0.005 U	0.027	0.031	9.5
	CRABDUP4_060309	06-03-2009	FD	8.6	0.013 J	0.019	0.033	8.6
CRAB19	CRAB19_060309	06-03-2009	ES	8.9	0.0097 J	0.021	0.03	8.9

Notes:
ES - environmental sample
FD - field duplicate
J - estimated value
mg/kg - milligram per kilogram (wet weight)
U - not detected above the reporting limit

7.0 TECHNICAL ASSESSMENT

7.1 FUNCTIONALITY OF REMEDY

Each component of the remedy is discussed in the sections that follow, generally in the order that the components were described in Section 4. In cases where a single overall action was taken to address multiple remedy components, those components are grouped within the sections below.

7.1.1 Functionality of Remedy for the Shoreline (Sites 101, 101-A, and 103)

Is the remedy functioning as intended by the decision document? Yes, the remedy for the shoreline is functioning as designed and progress is being made towards meeting the RAOs. Three of the RAOs for these sites were related to protection of the marine environment:

- Reduce the potential for erosion and transport of chemicals in soil to the marine environment.
- Protect ecological receptors in the marine environment and human health by attaining compliance with water quality standards for marine surface water at the point of groundwater discharge.
- For shellfish from Ostrich Bay, reduce risks from subsistence-level ingestion to less than 1×10^{-5} excess carcinogenic risk and less than a noncarcinogenic HI of 1.

Shoreline remedial actions included shoreline stabilization, monitoring of seeps and outfalls, and monitoring of shellfish tissue in Ostrich Bay.

Shoreline Stabilization

The shoreline stabilization along Ostrich Bay from Sites 101-A to 103 was constructed to prevent the erosion of impacted soil in order that soil contaminants would not enter the marine environment. In addition, impacted soil remaining in the shoreline areas of Sites 101 and 103 was covered and vegetated to further prevent the movement of contaminants into the bay.

The shoreline stabilization efforts appear to be working effectively to prevent erosion and transport, based on observations made during the site visit, the reports of interviewees, and the results of the inspection report. Continued effectiveness requires ongoing inspection and maintenance. The appropriate programs and activities are in place and are fulfilling inspection and maintenance requirements. The required land use controls are formalized in a Land Use Control Plan. Institutional controls inspections are being performed and documented yearly, and

documentation is available. The site inspections for this 5-year review indicate that the required land use controls have been maintained since signing the ROD and that the institutional controls component of the remedy is functional.

Seep and Outfall Monitoring

Ongoing monitoring of the seeps and outfalls along the shoreline has been performed as specified in the ROD. There have been few exceedances of the water quality RGs specified in the ROD, with the exception of benzene related to the Benzene Release Area (see Section 7.1.4). Other than benzene, there have been minor exceedances of RGs for five COCs: arsenic, beryllium, cyanide, mercury, and nickel. None of the exceedances has been large, consistent as to location, or substantially different from the time of the ROD. These results suggest that the soil removal and covering efforts that have occurred at the site over the last several years are effective in minimizing chemical concentrations entering the marine environment from groundwater.

Shellfish Monitoring

Shellfish monitoring has been conducted as specified in the ROD for clams and crabs, and three rounds of data are now available. Multiple human health risk assessments have been performed using the shellfish tissue data, in accordance with the ROD. The conclusion of the risk assessment based on the 2009 data (see Section 7.2.2) is that, although the RAO pertaining to human health risk from ingestion of shellfish may actually have been met at the site, additional data using better methods to detect ordnance compounds are needed.

The pilings offshore of Sites 101 and 103 were thought to be a potential source of 3,3'-dichlorobenzidine and PCP, and these COCs were a potential concern in shellfish. The pilings have been removed, and 3,3'-dichlorobenzidine and PCP have not been detected in shellfish. While the source of those two SVOCs is not definitively known, the remedy of pilings removal may have functioned as intended and removed the source for those two compounds.

Signs have been posted at regular intervals along Ostrich Bay to warn that shellfish harvesting is not allowed in the area. During this 5-year-review period the signs were upgraded to a sturdier version.

7.1.2 Functionality of Remedy for Upland Soil Areas (Sites 101, 101-A, 103, and 110)

Is the remedy functioning as intended by the decision document? Yes, the remedy for the upland soil areas is functioning as designed. The soil RAO for OU 1 (i.e., prevention of dermal contact with or ingestion of soil containing concentrations of COCs above state cleanup levels) has been achieved by removing surface soil containing COCs above cleanup levels and by covering the

subsurface soil that still contains COCs above RGs. An additional restriction was placed on land use at Site 103 of no residential development. For the areas of JPHC/NHB where subsurface COCs remain above cleanup levels, institutional controls are in place that would prevent uncontrolled digging or disturbance of any of these areas and would also prevent residential development at Site 103. The restricted areas have been clearly identified on maps and in the Land Use Control Plan for the site. The restrictions functioned as intended during this 5-year-review period, resulting in rerouting of a new water line to avoid contaminated soil in the Root Court cul-de-sac.

7.1.3 Functionality of Groundwater Remedy for Site 110

Is the remedy functioning as intended by the decision document? Yes, no specific remedy was implemented for the upland groundwater. Metal concentrations in groundwater at upland wells in Site 110 were to be sampled post-ROD and results reevaluated using new background data to assess whether concentrations really exceeded RGs. If there was no exceedance, the restrictions on the use of this groundwater for drinking could be lifted, with the concurrence of EPA and Ecology. The first 5-year review concluded that groundwater use restrictions were not necessary for upland groundwater beneath Site 110 outside of the Benzene Release Area, and the restrictions were removed with the concurrence of EPA and Ecology.

7.1.4 Functionality of Remedy for Benzene Release Area

Is the remedy functioning as intended by the decision document? No, the first 5-year review concluded that the ORC® injection remedy was not functioning as intended by the ROD. As a result of this finding, substantial additional investigation, pilot testing, and a removal action have been performed at the Benzene Release Area during this 5-year-review period. A complex hydrogeologic regime and the presence of free product have been revealed by the additional investigation work. Investigation, pilot testing, and product removal is ongoing, with progress toward a revised remedy for this area.

7.1.5 Operation and Maintenance Costs

Annual operation and maintenance (O&M) costs were estimated in the ROD to be $263,860 (not escalated from 2000). The breakdown in the ROD was as follows:

- Soil O&M: $27,000
- Groundwater O&M: $61,300
- Marine tissue O&M: $82,200
- Benzene Release Area O&M: $93,360

Actual O&M costs for 2005 through 2009 were approximately the following:

- 2005: $200,000
- 2006: $197,000
- 2007: $199,000
- 2008: $188,000
- 2009: $371,000 (including a marine tissue sampling event)

Comparison of the actual O&M costs to the estimate in the ROD does not indicate any issues with remedy functionality.

7.2 CONTINUED VALIDITY OF ROD ASSUMPTIONS

This section answers the question, "Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?" Therefore, this section reviews any changes to ARARs used to establish RGs in the ROD and reviews any changes to risk assessment assumptions (exposure and toxicity) to evaluate the protectiveness of the remedy.

The findings of this section are that changes in the ARARs and exposure and toxicity assumptions since the ROD was signed do not affect the protectiveness of the remedy. Concentrations of some COCs in surface water remain above the RGs at seeps and outfalls, resulting in the need for continued institutional controls to prevent exposure and ongoing monitoring. Although some of the surface and groundwater RGs might be lower if calculated today, the remedy components continue to protect against exposures, just as they did at the time the ROD was signed. Institutional controls preventing exposure and ongoing monitoring will need to continue until COC concentrations in groundwater and surface water are below the RGs. Specific changes are summarized as follows:

- Copper and zinc would have lower RGs if established today, but LTM results are at background and below the lowest current ARAR. Therefore, monitoring for these chemicals may no longer be necessary.

- Chlordane would have a lower RG if established today, but the chemical has not been detected in the last 5 years of monitoring. Therefore ongoing monitoring may no longer be necessary.

- Benzene would have a lower RG if established today, and current monitoring is still detecting concentrations above the ROD RG. However, the ROD RG represents a risk level below the ROD cancer risk goal of 1×10^{-5}, using current toxicity criteria. Therefore, the ROD RG is still protective. When ROD RG

concentrations are met, it is recommended that the RG be reviewed prior to discontinuing monitoring.

- TCE would have a lower RG if established today. Current monitoring indicates results still above the ROD RG at one seep location, but no other location exceeds the ROD RG or the current MTCA B cleanup level. However, the ROD RG represents a risk level below the cancer risk goal of 1×10^{-5}, using current toxicity criteria. Therefore, the ROD RG is still protective. When the ROD RG is met at all locations, it is recommended that the RG be reviewed prior to discontinuing monitoring.

RGs were not established for marine tissue in Ostrich Bay. Rather, the ROD stated that harvesting restrictions were to be removed when health risks from ingesting shellfish at subsistence consumption levels met the RAOs. The results of the human health risk assessment conducted using the latest data (collected in 2009) are presented in Section 7.2.2. Based on these results, the ROD RAO to continue monitoring and restrict harvesting until risks are representative of background levels and/or are below target health goals has potentially been met, although additional data collection is needed to support this conclusion. Risks based on the exposures assumptions used in the original RI are acceptable. However, risks based on new information (Suquamish Tribe ingestion rates) do not meet target goals if ordnance compounds are actually present. The quality of the ordnance data is poor and is the basis for the additional data collection recommendation.

7.2.1 Review of Applicable or Relevant and Appropriate Requirements

In the preamble to the NCP, EPA stated that ARARs are generally "frozen" at the time of ROD signature, unless new or modified requirements call into question the protectiveness of the selected remedy. Five-year review guidance (USEPA 2001) indicates that the question of interest in developing the 5-year review is not whether a standard identified as an ARAR in the ROD has changed in the intervening period, but whether this change to a regulation calls into question the protectiveness of the remedy. If the change in the standard would be more stringent, the next stage is to evaluate and compare the old standard and the new standard and their associated risk. This comparison is done to assess whether the currently calculated risk associated with the standard identified in the ROD is still within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}. If the old standard is not considered protective, a new cleanup standard may need to be adopted after the 5-year review through CERCLA's processes for modifying a remedy.

The result of the amendments to the regulations is sometimes the lowering of a numeric ARAR. In these instances, the revised ARAR must be evaluated to determine whether there is a negative effect on the protectiveness of the remedy. In other instances, the ARAR remains unchanged or has been raised.

During the first 5-year review for JPHC/NHB, no substantive change was found to ARARs that would call into question the protectiveness of the remedy. For this 5-year review, all the ARARs identified in the ROD were again reviewed for changes that could affect the assessment of whether the remedy is protective. Based on this review, it was concluded that three of the regulations listed as ARARs have changed. These regulations are the following:

- Washington State MTCA regulations
- Federal marine ambient water quality criteria
- Washington State marine surface water quality standards

In addition to establishing risk-based cleanup levels, MTCA also allows for use of background or the laboratory PQL as a cleanup level when the MTCA cleanup level is lower than these values. Based on new analytical techniques, laboratories now are able to readily achieve lower PQLs for some COCs. When cleanup levels are established as PQLs and the PQLs decrease with improved technology, the 5-year-review process does not typically recommend revising the cleanup levels during every 5-year review. Instead, the 5-year review includes an assessment of whether the latest PQLs are being used for monitoring and decision making.

RGs were established for soil, groundwater, and surface water. The ARAR review is summarized by media in the following sections.

Soils at 101, 101-A, 103, 110

The RGs established for soil are shown on Table 7-1. RGs were based on MTCA Method B or background for residential soils at areas 101, 101-A, and 110 and on MTCA Method C for industrial soils at area 103. As shown on Table 7-1, if RGs were established today, they would be the same or higher than those established at the time of the ROD. Under the November 2007 revision of MTCA (Washington Administrative Code 173-340-708[8][e]), determining compliance with cleanup levels for mixtures of cPAH compounds is now done by calculating a benzo(a)pyrene "equivalent" value for each sample. This toxic equivalent concentration is derived by adjusting the concentrations of the seven cPAHs based on their toxicity compared to benzo(a)pyrene. The sum of the adjusted concentrations is then calculated and compared to the RG. The new compound-specific cleanup levels would be the same (Sites 101, 101-A, 103, and 110) or higher (Site 103) than the RGs established in the ROD, and the new method of evaluating cPAHs does not call into question the protectiveness of the remedy.

Groundwater at Sites 101, 101-A, and 103

The point of compliance for groundwater at these sites was established to be the point where groundwater enters the marine environment. As such, the RGs are based on ambient water quality criteria protective of human and ecological receptors in the marine environment. Some of the COCs had been detected in seeps and outfalls, while some had only been detected in inland wells at these sites. The nine shoreline COCs and potential ARAR changes are shown on Table 7-2, while the additional seven inland COCs (i.e., those not detected at the shoreline at the time of the ROD) are shown on Table 7-3. The inland COCs were added to the LTM program at the seeps and outfalls as required by the ROD.

The ARARs for the protection of surface water have changed for many of the COCs in groundwater as shown on Tables 7-2 and 7-3. However, most of the changes resulted in higher values (i.e., the ROD values are more protective than necessary, based on the current ARAR). For those chemicals with lower ARARs none of the changes affects the protectiveness of the remedy. For the shoreline COCs, benzene and TCE would have lower RGs today because of changes in toxicity. These changes and the impacts on protectiveness are discussed further in Section 7.2.2. Three inland COCs, copper, zinc, and chlordane, would also have lower RGs today. However, LTM for these chemicals indicates concentrations are either not detected or are below the most stringent current standard. Chlordane has never been detected at the shoreline, while copper and zinc have never been detected above background concentrations (the background concentrations were established in 2001 [U.S. Navy 2001]).

Note that mercury's RG was adjusted from the ROD level of 0.025 to 0.1 µg/L based on the PQL (U.S. Navy 2001). As shown on Table 6-5, mercury has been detected in only 3 out of 89 samples from 2002 through 2009 (2 detections in 2002 and 1 in 2004). Since 2006, the PQL has often been as low as the RG of 0.025 µg/L (either 0.02 or 0.03 µg/L), indicating that the original ROD level can now frequently be achieved by laboratories and that mercury concentrations are likely below the original ROD RG level of 0.025 µg/L. The PQL value of 0.1 µg/L established in 1991 is no longer an appropriate RG.

Groundwater at Site 110

ROD RGs for groundwater at this site (five metals—arsenic, beryllium, manganese, nickel, and vanadium) were based on drinking water standards (except for arsenic, which was based on background) because it would be possible to drink the water, although groundwater is not being used (see Table 7-4). Two rounds of post-ROD monitoring did not find concentrations in excess of RGs and monitoring was discontinued. None of these COCs would have more stringent (i.e., lower) RGs if cleanup levels were established today, and groundwater use restrictions, which were removed as a result of the first 5-year review, continue to be unnecessary.

7.2.2 Review of Risk Assessment Assumptions

Risk assessment assumptions were also reviewed as part of the requirement to assess protectiveness of the remedy. The two areas where changes have occurred since the ROD are toxicity values for five chemicals and the fish ingestion exposure parameter. Toxicity changes and exposure assumption changes are discussed separately in the sections that follow.

Toxicity Criteria

As part of the RG selection process in the ROD, a MTCA Method B value protective of surface water exposures was selected as the RG if there was no background value and if the Method B value was the most stringent ARAR (see Tables 7-2 and 7-3). If Method B values were to be calculated now, revisions to the toxicity criteria for five chemicals would result in different MTCA Method B values than those presented in the ROD. Three of the COCs would have higher cleanup levels if established today (beryllium, 1,1-DCE, and vinyl chloride) and two COCs (benzene and TCE) would have lower cleanup levels. Therefore, MTCA Method B values were recalculated using current toxicity values and compared to the ROD RGs. The results of the recalculation and the specific toxicity changes are presented in Table 7-5 and are discussed below.

Beryllium. EPA's Integrated Risk Information System (IRIS) does not currently report an oral carcinogenic toxicity value (slope factor) for beryllium and considers the data inadequate to evaluate carcinogenicity by ingestion (USEPA 2009). The previous study that the EPA used to estimate the oral slope factor used to calculate the MTCA Method B value in the ROD (4.3 $[mg/kg\text{-}d]^{-1}$) was based on a study now considered by EPA to be inadequate for the assessment of carcinogenicity (USEPA 2009). The chronic oral studies did not report increased incidences of tumors in rodents, but were conducted at doses that may have been too low to cause cancer effects. Despite the uncertainties in the dose range, EPA has concluded that beryllium cannot be evaluated as a carcinogen by the oral route (ingestion) and, therefore, should be evaluated as a noncarcinogen for the purposes of the MTCA Method B calculation. (Note: Inhaled beryllium is characterized as a "likely" human carcinogen as reported by EPA's IRIS [USEPA 2009].) Because MTCA Method B surface water values are protective of an ingestion pathway (eating fish), the oral pathway is the pathway of concern. If the current oral reference dose (0.002 [mg/kg-d]) is used to calculate the MTCA Method B value, the new value would be 273 µg/L (based on surface water protection). This change does not affect the protectiveness of the remedy, because the RG is considerably lower than the new MTCA Method B value. In addition, the LTM at the site's seeps and outfalls has detected beryllium infrequently and at concentrations only slightly greater than the RG.

Benzene. At the time of the ROD, the oral slope factor for benzene was not available on IRIS. Therefore, the inhalation slope factor (0.029 $[mg/kg\text{-}d]^{-1}$) was used to calculate a MTCA Method B value. Currently, IRIS reports an oral slope factor of 0.055 $(mg/kg\text{-}d)^{-1}$. Because MTCA Method B surface water values are protective of an ingestion pathway (eating fish impacted by the chemical), the oral slope factor should be used for the MTCA Method B surface water calculations. Ecology is now using the oral slope factor in the benzene surface water calculation (<http://www.ecy.wa.gov/programs/tcp/tools/CLARC_v_3.1>). Using the current oral slope factor to calculate the MTCA Method B value results in an ARAR change from 43 to 22.7 µg/L. Using the new slope factor, the cancer risk of the RG of 43 µg/L is 2×10^{-6}, below the ROD cancer risk goal of 1×10^{-5}. Because the ROD cancer goal is still being met, the remedy designed to achieve the RG is protective, and no RG change is recommended.

1,1-Dichloroethene. Today's RG would be higher than the ROD value because EPA has withdrawn the cancer slope factor for this chemical and no longer considers it a potential carcinogen. If a MTCA Method B surface water value were calculated now, it would be based on noncancer toxicity and would be higher than the RG selected in the ROD. The ROD cleanup value for the surface water pathway is based on the MTCA Method B value available at the time the ROD was prepared, when DCE was considered a potential carcinogen. The former MTCA Method B calculated value was 1.93 µg/L, and the current value is 23,100 µg/L. The new ARAR value for the surface water pathway is therefore less stringent, and there is no impact on the protectiveness of the remedy. Because this chemical has not been detected in the last 5 years (Table 6-1) discontinuation of monitoring for 1,1-DCE should be considered.

Trichloroethene. TCE is a COC in groundwater at Sites 101, 101-A, 103, and the Benzene Release Area. The ROD cleanup value for the surface water pathway is based on the MTCA method B value available at the time the ROD was prepared. The former MTCA Method B calculated value was 56 µg/L, and the current value is 6.7 µg/L. The new ARAR value for the surface water pathway is therefore more stringent. Using the current slope factor to recalculate the health risk of exposure to TCE via the surface water pathway at the seeps and outfalls, the current ARAR represents a health risk of 9×10^{-6}, which is below the ROD goal of 1×10^{-5}. Therefore, the protectiveness of the remedy is not currently affected.

Concentrations of TCE in surface water at the seeps and outfalls do not exceed the latest MTCA Method B value of 6.7 µg/L (see Table 6-1), except at location OF-705 in Site 103 (which still also exceeds the RG of 55.6 µg/L). Prior to discontinuation of monitoring, the RG should be reviewed to assess protectiveness.

Vinyl Chloride. The oral slope factor for vinyl chloride, as reported in IRIS (USEPA 2009), has changed from 1.9 to 1.5 $(mg/kg\text{-}d)^{-1}$. If the current oral slope factor is used to calculate the MTCA Method B value, a slightly higher cleanup level would be calculated, changing it from 2.92 to 3.69 µg/L. This change would not influence the protectiveness of the remedy. Vinyl

chloride has not been detected in the last 5 years (Table 6-1), and discontinuation of monitoring for this chemical should be considered.

Exposure Assumptions – Benzene Release Area

The 2007 EE/CA for the Benzene Release Area identified a number of complete and potentially significant pathways for human and ecological receptors that had not previously been evaluated (U.S. Navy 2007c):

- Inhalation of vapors generated from groundwater and subsurface soil intruding into buildings (commercial workers and residents)
- Direct contact with chemicals in subsurface soil and groundwater in areas of the site where contamination has been identified within 15 feet of the ground surface (utility workers)
- Inhalation of vapors generated from groundwater and subsurface soil into outdoor air (utility workers)
- Incidental ingestion and inhalation of and dermal contact with surface water and sediment during recreational activities (residents)
- Potential impacts to terrestrial and aquatic receptors in the near-shore areas of Ostrich Bay

The current plan is for these pathways to be evaluated as part of the focused FS planned for 2010 and based partly on data collection efforts currently underway.

Exposure Assumptions – Sites 101, 101-A, and 103

An important part of the remedy for JPHC/BNC is the prevention of adverse human health effects from ingestion of shellfish in Ostrich Bay. There were no RGs developed for marine tissue. Instead, the ROD stated that harvesting restrictions were to be removed when health risks from ingesting shellfish at subsistence consumption levels met the RAOs. The ROD required shellfish harvesting restrictions, because the baseline risk assessment (done as part of the RI) identified possible health risks in excess of target health goals if shellfish were consumed at a subsistence level.

The exposure parameters used in the baseline risk assessment for subsistence and recreational harvesters of shellfish were a combination of EPA default parameters and parameters obtained from peer-reviewed literature. With regard to subsistence exposures, subsequent to the original

risk assessment, the Suquamish Tribe has conducted a study on tribal-specific fish ingestion rates (Suquamish Tribe 2000), and the regional EPA office has published new guidance on fish ingestion risk assessments for EPA Region 10 (USEPA 2007). The Suquamish Tribe has "usual and accustomed" fishing rights in Ostrich Bay, and, thus, Suquamish information is most applicable to subsistence harvesters in this area. A risk assessment was conducted using the 2009 tissue data (U.S. Navy 2009e) in advance of this 5-year review. The risk assessment used the 2009 tissue data, Suquamish ingestion rates, and latest EPA guidance and also evaluated risks using the same exposure parameters as were used in the original baseline risk assessment (Suquamish subsistence and "RI" subsistence populations).

The first 5-year review recommended shortening the original COC list (based on lack or detections and chemicals at background) to arsenic and ordnance compounds. Therefore, the 2009 data (clams and crabs) included only arsenic and ordnance compounds as the COCs.

Based on the 2009 risk assessment, the ROD requirement to continue monitoring and harvest restrictions until risks are representative of background levels and/or are below target health goals has not been met, because health risks are above target health goals for the Suquamish population (target goals have essentially been met for other populations). Exceedance of health goals is primarily because of two dinitrotoluene (DNT) isomers and secondarily because of arsenic. Clams appear to be the primary species of concern, and crab concentrations did not represent a significant health risk. However, there are significant quality issues with the DNT data and, while the risk assessment conservatively treated the DNT compounds as detected, it is unclear whether those compounds are actually present in clam tissue. In addition, arsenic concentrations are likely at background. Additional data are needed using better methods to detect ordnance compounds. Specific conclusions of the 2009 risk assessment are the following:

- **Arsenic concentrations are at background and are not related to the site.** Concentrations of arsenic in crabs at the site were equal to or below concentrations at the reference area. Concentrations of arsenic in clams were higher on site (a site average of 0.04 mg/kg compared to a reference area average of 0.03 mg/kg), and the difference in concentrations was found to be statistically significant, although the data sets were relatively small. However, in the absence of an arsenic source (arsenic seep concentrations are at background [Table 6-5]), the slightly higher clam concentrations cannot be attributed to site activities and most likely result from the natural variability of metal concentrations in the environment. This conclusion is confirmed by the 2002 Ecology report that concluded that the presence of inorganic arsenic concentrations in clam and crab tissues collected from Puget Sound water bodies, including Dyes Inlet and Ostrich Bay, are from natural background arsenic sources and not anthropogenic sources (WDOE 2002).

- **DNT isomers are unlikely to be present.** As noted above, the presence of DNT in clam tissue cannot be confirmed, although the data were conservatively included in the risk calculations. DNT compounds are not bioaccumulative, have fairly short half-lives in water in the presence of oxygen and sunlight, and are subject to microbial degradation. Because ordnance-related activities at the site have not occurred since 1959 (i.e., no new sources of DNT since that time), the likelihood of DNTs still being present in significant amounts is low. If any remaining concentrations were present, they would continue to degrade. In addition, no DNT compound has been detected in groundwater or seep water at the site since the RI (1996 and 1998 sampling of groundwater and surface water seeps did not detect any ordnance compound).

- **No ordnance compound is present in significant concentrations.** Only a handful of ordnance compounds have ever been detected in clam and crab tissues in the three post-ROD monitoring events (2002, 2004, and 2009). All previous detections have been low (close to the analytical reporting limits and below risk-based levels), and many of the detections have been qualified in some way, as were the DNT results in the 2009 data. These results suggest that no ordnance-related compound is present in clams and crabs in significant concentrations (see Section 6.4.4).

Based on the lack of consistent, definitive detections of ordnance compounds, the fact that DNT isomers are unlikely to be present because of environmental degradation, and that arsenic concentrations are at background, it is likely that the ROD goals have been met. However, because of the uncertainties in the data, at least one more round of monitoring with improved analytical methods (currently being researched) is recommended.

7.3 NEW INFORMATION

This section is in response to the question "Has any other information come to light that could call into question the protectiveness of the remedy?" No other information reviewed during this 5-year review, apart from what is included previously in this document, affects the protectiveness of the remedy.

7.4 TECHNICAL ASSESSMENT SUMMARY

Except for the Benzene Release Area, the remedies are functioning as intended by the ROD, and progress towards meeting RAOs has been made since the completion of the remedy. The following summarizes the assessment:

- Erosion of soil into Ostrich Bay is being prevented by the shoreline stabilization work that occurred as part of the remedy.

- There are mechanisms in place to ensure that the shoreline stabilization system is inspected and properly maintained.

- Soil covers over areas containing concentrations above RGs are being maintained, and an institutional controls program has been implemented.

- The infrequent and low-magnitude exceedances of RGs at the seeps and outfalls indicate that most of the groundwater entering the Bay is in compliance with the goals of the remedy. Other than benzene, there have been minor exceedances over an RG for five COCs: arsenic, beryllium, cyanide, mercury, and nickel. Except for benzene, none of the exceedances has been large, consistent as to location, or substantially different from the time of the ROD.

- Benzene concentrations at OF-712 still exceed the RG and are within the range of concentrations measured at the time of the ROD. The first 5-year review concluded that the ORC® injection remedy was not functioning as intended by the ROD. As a result of this finding, substantial additional investigation, pilot testing, and a removal action have been performed at the Benzene Release Area during this 5-year review period. A complex hydrogeologic regime and the presence of free product have been revealed by the additional investigation work. Investigation, pilot testing, and product removal is ongoing, with progress toward a revised remedy for this area.

- Changes in the ARARs and exposure and toxicity assumptions since the RODs were signed do not affect the protectiveness of the remedy.

- Based on the results of a 2009 human health risk assessment, the ROD requirement to continue monitoring and restrict harvesting until risks are representative of background levels and/or are below target health goals has potentially been met, although additional data collection are needed to support this conclusion. Risks based on the exposures assumptions used in the original RI are acceptable. However, risks based on new information (Suquamish Tribe ingestion rates) do not meet target goals if ordnance compounds are actually present. The quality of the ordnance data is poor and is the basis for the additional data collection recommendation.

Table 7-1
ARARs for COCs in Soil at Sites 101, 101-A, 103, and 110

Chemical	Sites 101, 101-A, and 110				Site 103			
	ROD RG	Basis	Today's Value	Change?	ROD RG	Basis	Today's Value	Change?
Antimony	32	MTCA B	32	No	128	MTCA C	1,400	Yes, higher
Arsenic	8.6	Background	0.36	No (MTCA B greater than background)	66.7	MTCA C	88	Yes, higher
Beryllium	1.5	Background	160	Yes, higher	9.3	MTCA C	7,000	Yes, higher
Lead	250	MTCA A	250	No	250	MTCA A	1,000	Yes, higher
cPAHs	0.137	MTCA B	(a)	Yes[a]	5.48	MTCA C	18	Yes, higher
PCBs	0.130	MTCA B	0.5	Yes, higher	5.19	MTCA C	66	Yes, higher
TPH-G	100	MTCA A	100	No	100	MTCA A	100	No

[a]The over-all approach for evaluating cPAHs has changed under the November 2007 revision of MTCA (Washington Administrative Code 173-340-708[8][e]). Determining compliance with cleanup levels for mixtures of cPAH compounds is now done by calculating a benzo(a)pyrene "equivalent" value for each sample. This toxic equivalent concentration is derived by adjusting the concentrations of the seven cPAHs based on their toxicity compared to benzo(a)pyrene. The sum of the adjusted concentrations is then calculated and compared to the RG.

Notes:
ARARs - applicable or relevant and appropriate requirements
COCs - chemicals of concern
cPAHs - carcinogenic polycyclic aromatic hydrocarbon
MTCA - Model Toxics Control Act
PCBs - polychlorinated biphenyls
RG - remediation goal
ROD - Record of Decision
TPH-G - total petroleum hydrocarbon—gasoline

Table 7-2
ARARs for COCs at OU 1 Groundwater Sites 101, 101-A, and 103

Chemical	ROD Selected Cleanup Level (µg/L)	Basis of Cleanup Level	Revised Cleanup Level Based on Background Study (µg/L)	Current Chemical-Specific ARAR for Surface Water Protection (µg/L)				Change in Cleanup Level if Established Today?
				MTCA Method B	State AWQC	National AWQC	Federal NTR (HH)	
Volatile Organic Compounds								
Benzene	43	MTCA B	NA	22.7	36	36	71	Yes, lower
1,1-Dichloroethene	1.93	MTCA B	NA	23,100	None	None	3.2	Yes, higher
Trichloroethene	56	MTCA B	NA	6.7	None	None	81	Yes, lower
Vinyl chloride	2.92	MTCA B	NA	3.69	None	None	525	Yes, higher
Metals								
Arsenic - total	3.3	Background	3.7[a]	0.0982	36	36	0.14	No
Beryllium - total	0.0793	MTCA B	N/A	273	None	None	None	Yes, higher
Mercury - total	0.025	Marine chronic AWQC	0.1[b]	None	0.025	0.94	0.15	No (either a new PQL or the ROD RG)[b]
Nickel - dissolved	7.9	Marine chronic AWQC	N/A	1100	8.2	8.2	4600	Yes, higher
Silver - dissolved	1.2	Marine acute AWQC	N/A	25,900	1.9	1.9	None	Yes, higher

[a]Basis of cleanup level revised from original ROD to background level after completion of metals background study (U.S. Navy 2001), because background levels were higher than the most stringent ARAR.
[b]Basis of cleanup level was revised from original ROD to the practical quantitation limit (PQL). PQLs at the remediation goal (RG) level of 0.025 µg/L can now be achieved. Therefore, the ROD RG of 0.025 µg/L would apply to mercury at the site.

Notes:
ARAR - applicable or relevant and appropriate requirement
AWQC - ambient water quality criteria
COCs - chemicals of concern
HH - the AWQC based on human ingestion of fish in the water body
µg/L - microgram per liter
MTCA - Model Toxics Control Act
NTR - National Toxics Rule
ROD - Record of Decision
NA - not applicable

Table 7-3
ARARs for COCs in Upland Wells at OU 1 Groundwater Sites 101, 101-A, and 103

Chemical	ROD Selected Cleanup Level (µg/L)	Basis of Cleanup Level	Revised Cleanup Level Based on Background Study (µg/L)	Current Chemical-Specific ARAR for Surface Water Protection (µg/L)				Change in Cleanup Level if Established Today?
				MTCA Method B	State AWQC	National AWQC	Federal NTR (HH)	
Copper - dissolved	58	Marine acute AWQC[a]	4.8	2,665	4.8	4.8	None	Yes, lower
Cyanide	1	Marine acute AWQC	N/A	51,900	1	1	220,000	No
Lead - dissolved	6	Marine chronic AWQC	5.8[a]	None	8.1	8.1	None	Yes, higher
Thallium - total	1.56	MTCA B	N/A	1.56	None	None	6.3	No
Zinc - dissolved	104	Marine chronic AWQC	81[a]	16,500	81	81	None	No
Chlordane	0.0022	Federal NTR (HH)	NA	0.0013	0.004	0.004	0.00059	Yes, lower
Total petroleum hydrocarbon	1,000	MTCA A	NA	1,000	None	None	None	No

[a]Basis of cleanup level was revised from original ROD to background level after completion of metals background study (U.S. Navy 2001).

Notes:
ARAR - applicable or relevant and appropriate requirement
AWQC - ambient water quality criteria
COCs - chemicals of concern
HH - the AWQC based on human ingestion of fish in the water body
µg/L - microgram per liter
MTCA - Model Toxics Control Act
NTR – National Toxics Rule
ROD - Record of Decision
NA - not applicable

Table 7-4
ARARs for COCs in Groundwater at Site 110

Chemical	ROD Selected Cleanup Level (µg/L)	Basis of Cleanup Level	Revised Cleanup Level Based on Background Study (µg/L)	ARAR Based on Drinking Water		Change in Cleanup Level if Established Today?
				MTCA Method B (µg/L)	MCL (µg/L)	
Arsenic	3.3	Background	3.7	0.058	10	No
Beryllium	0.0793	MTCA B	N/A	32	4	Yes, higher
Manganese	2,240	MTCA B	NA	2,200	50 (secondary MCL)	No
Nickel	100	MCL	NA	320	100 (State value; Federal value remanded)	No
Vanadium	112	MTCA B	NA	110	None	No

Notes:
ARARs - applicable or relevant and appropriate requirements
COCs - chemicals of concern
MCL - maximum contaminant level
µg/L - microgram per liter
MTCA - Model Toxics Control Act
ROD - Record of Decision

Table 7-5
Changes in Toxicity Values

Chemical	MTCA Method B Value in ROD Selected as RG (µg/L)	MTCA Method B Value for Surface Water Based on New Toxicity (µg/L)	Reason for Revision
Beryllium	0.0793	273	See text for further discussion.
Benzene	43	22.7	An inhalation slope factor of 0.029 $(mg/kg\text{-}d)^{-1}$ was used previously. An oral slope factor of 0.055 $(mg/kg\text{-}d)^{-1}$ is currently available.
1,1-Dichloroethene (DCE)	1.93	23,100	DCE is no longer considered a potential carcinogen. New value is for noncancer.
Trichloroethene (TCE)	56	6.7	MTCA calculations now incorporate a slope factor for TCE of 0.089 $(mg/kg\text{-}d)^{-1}$.
Vinyl chloride	2.92	3.69	Oral slope factor changed from 1.9 to 1.5 $(mg/kg\text{-}d)^{-1}$.

Notes:
µg/L - microgram per liter
mg/kg-d - milligram per kilogram per day
MTCA - Model Toxics Control Act
RG - remediation goal
ROD - Record of Decision

Table 7-6
Issues

No.	Issue	Affects Protectiveness	
		Current	Future
1	Land use controls related to discarded military munitions are currently separate from other land use controls at the site and are not included in the Land Use Control Plan.	Yes[a]	Yes[a]
2	The mercury RG established post-ROD and used in monitoring documents is above the current PQL, and the cyanide RG does not account for PQL limitations. Benzene and trichloroethene would have lower RGs if calculated today.	No[b]	Yes[b]
3	The remedy for the Benzene Release Area is not functioning as intended by the ROD.	Yes	Yes
4	Groundwater containing benzene at concentrations exceeding the RG is discharging to Ostrich Bay.	Yes	Yes
5	Unresolved questions remain regarding whether ordnance compounds are present in marine tissue, whether risks to human health from these compounds are unacceptable, and whether arsenic concentrations in marine tissue present a risk to human health above background risks.	Yes	Yes
6	Monitoring requirements for seeps and outfalls should be updated based on the monitoring results since the time of the ROD. The RGs used in the monitoring documents for copper and zinc do not match the ROD or post-ROD background study values.	No[c]	No[c]

[a]Although both sets of land use controls are effective, the separation could cause inadvertent compliance with only one set of land use controls and not the other for a particular project.
[b]Current protectiveness is not called into question, because institutional controls remain in place. Future protectiveness could be called into question if changes to monitoring programs or institutional controls are made without considering potential changes to the basis of RGs.
[c]Monitoring program changes are recommended to focus data collection on analytes and areas of the site that show trends of chemicals of concern exceeding RGs after remedy implementation. However, the monitoring program is protective as it stands.

Notes:
PQL - practical quantitation limit
RG - remediation goal
ROD - Record of Decision

8.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section presents the recommendations and follow-up actions identified as a result of the 5-year review process. Table 8-1 summarizes the recommendations.

Table 8-1
Recommendations and Follow-Up Actions

No.	Recommendation/Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness	
					Current	Future
1	Update the Land Use Control Plan to include DMM-related land use controls, inspections, and reporting, and complete the land use control base instruction covering Jackson Park Housing Complex and Naval Hospital Bremerton.	NAVFAC NW	EPA	12/31/2012	Yes	Yes
2	Review the basis of the RG (i.e., applicable or relevant and appropriate requirements, practical quantitation limits, and risk assessment assumptions) prior to any change in monitoring or institutional controls requirements.	NAVFAC NW	EPA	Ongoing	No	Yes
3	Complete additional investigation and pilot testing related to the Benzene Release Area, and optimize the remedy for this area.	NAVFAC NW	EPA	12/31/2015	Yes	Yes
4	Develop a proposal for an interim action to address the discharge of groundwater containing benzene to Ostrich Bay.	NAVFAC NW	EPA	12/31/2010	Yes	Yes
5	Perform an additional marine tissue sampling event utilizing the newly developed methods for ordnance compounds in marine tissue. Use the results of this event to verify the 2009 human health risk conclusions. Develop the sampling and analysis plan and quality assurance project plan for this sampling event in consultation with EPA and the Suquamish Tribe.	NAVFAC NW	EPA	12/31/2011	Yes	Yes
6	Revise the long-term monitoring plan to incorporate the specific changes listed in Section 6.4 of this review and the correct RGs for copper and zinc.	NAVFAC NW	EPA	12/31/2012	No	No

Notes:
DMM - discarded military munitions
EPA - U.S. Environmental Protection Agency
NAVFAC NW - Naval Facilities Engineering Command Northwest
RG - remediation goal

9.0 CERTIFICATION OF PROTECTIVENESS

The remedies implemented for OU 1 at JPHC/NHB are protective both in the short and long terms, with the exception of the Benzene Release Area and human consumption of marine tissue.

The remedy in the Benzene Release Area is not protective, because benzene concentrations in seep water discharging to Ostrich Bay continue to exceed the RG. Investigation, pilot testing, and removal actions are underway at the Benzene Release Area, with progress toward determining a revised remedy. The revised remedy is expected to be protective once selected and implemented.

The protectiveness of the remedy with regard to human consumption of marine tissue cannot be determined at this time, because analysis of marine tissue for ordnance compounds has not yet been performed using the recently developed analytical methodologies. Until such analysis can be completed, human exposure to marine tissue is being prevented through institutional controls that prohibit harvesting of shellfish from Ostrich Bay.

The remedies for OU 2 and OU 3 will be selected based on their protectiveness of human health and the environment. The remedies are therefore expected to be protective, once selected and implemented.

10.0 NEXT REVIEW

The next 5-year review is tentatively scheduled for 2015.

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APPENDIX A
Site Inspection Forms

I. SITE INFORMATION	
Site name: *Jackson Park Housing Complex/Naval Hospital Bremerton*	**Date of inspection:** *September 17, 2009*
Location and Region: *Bremerton, WA, Region 10*	**EPA ID:** *WA3170090044*
Agency, office, or company leading the five-year review: *US Navy*	**Weather/temperature:** *Sunny, 70 °F*

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☐ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- ☒ Other *Soil removal; shoreline stabilization; groundwater, seep, and shellfish monitoring; oxygen-releasing compound remediation*

Attachments: ☒ Inspection team roster in body of report ☒ Site map in body of report

II. INTERVIEWS (Check all that apply)

1. **Navy Staff**

Contact: Karan Holmes, Remedial Technical Manager

Problems; suggestions; ☒ Report attached: See Appendix B

Contact: Dwight Leisle, RPM (JPHC OU 2)

Problems; suggestions; ☒ Report attached: See Appendix B

Contact: Robert Mitchell, Environmental Manager

Problems; suggestions; ☒ Report attached: See Appendix B

Contact: Douglas Thelin, RPM

Problems; suggestions; ☒ Report attached: See Appendix B

Contact: Dianne Vogel, Remedial Program Manager, Environmental Coordinator and Customer Relations Coordinator

Problems; suggestions; ☒ Report attached: See Appendix B

Contact: Leslie Yuenger, Public Affairs Officer

Problems; suggestions; ☒ Report attached: See Appendix B

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2. **Regulatory and Tribal authorities and response agencies**

Agency: Washington State Department of Ecology
Contact: Barry Rogowski

Problems; suggestions; ☐ Report attached:
Elected not to respond

Agency: U.S. Environmental Protection Agency
Contact: Harry Craig

Problems; suggestions; ☐ Report attached:
Did not respond

Agency: Suquamish Tribe
Contact: Denice Taylor

Problems; suggestions; ☐ Report attached:
Indicated that a response would be forthcoming after review of risk assessment materials.

3. **Members of the public**

Contact: Various RAB members

Problems; suggestions; ☐ Report attached:
No response

4. **Other interviews** (optional): None.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Records**

☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A
☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A

Remarks: *Inspection and Maintenance Plan updated August 2008.*

2. **Institutional Controls Inspection Records** ☒ Readily available ☒ Up to date
Remarks:

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house	☐ Contractor for State
☐ PRP in-house	☐ Contractor for PRP
☐ Federal Facility in-house	☒ Contractor for Federal Facility
☐ Other	

2. **O&M Cost Records**
☒ Readily available ☒ Up to date
☒ Funding mechanism/agreement in place
Original O&M cost estimate:

Total annual cost by year for review period if available: *Annual average has been $230,823*

From *FY 2005*	To _____	*$200,000*		
Date	Date	Total cost		
From *FY 2006*	To _____	*$196,734*		
Date	Date	Total cost		
From *FY 2007*	To _____	*$198,600*		
Date	Date	Total cost		
From *FY 2008*	To _____	*$187,832*		
Date	Date	Total cost		
From *FY 2009*	To _____	*$370,947*	*(Includes marine tissue sampling event)*	
Date	Date	Total cost		

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons:

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Elwood Point (Site 103)

1. **Has non-residential land use been maintained?** ☒ Yes ☐ No
Remarks: _____

2. **Are the barriers over soil still in place?** ☒ Yes ☐ No
Remarks: _____

3. **Are the non-vegetative covers intact and is the vegetative cover maintained/healthy?**
☒ Yes ☐ No
Remarks: _____

4. **Any digging without dig permit?** ☐ Yes ☒ No
Remarks: _____

5. **Any activities that could interfere with remedy or monitoring?** ☐ Yes ☒ No
Remarks: _____

6. **Any disturbance to the sensitive archaeological area (outside IC area)?** ☐ Yes ☒ No
Remarks: _____

B. Upland Areas (Sites 110 and 101-A) (1: Bldg 100/Bldg 101; 2: Root Court Cul-de-Sac; 3: Root Court/S. Shore Fill Areas; 4: Construction Debris Landfill)

1. **Are asphalt covers being maintained in front of Buildings 100 and 101?**
☒ Yes ☐ No
Remarks: *Bldg 100 – New asphalt overlay 3-4 years ago. Bldg 101 – extended asphalt to east to provide more comprehensive cover of impacted soil.*

2. **Are soil and vegetative covers maintained/ healthy at the Root Court Cul-de-Sac?**
☒ Yes ☐ No
Remarks: _____

3. **Any digging without dig permit in any of the upland areas?** ☐ Yes ☒No
Remarks: *RPM reviewed plans for City water line through Root Court and rerouted pipeline around capped circle area. Pipeline digging did not impact IC area.*

4. **Are there any signs of erosion or exposed soils in the Root Court or Construction Landfill areas?**
☐ Yes ☒ No
Remarks: _____

5. **Groundwater wells installed?** ☐ Yes ☒ No
Remarks:

C. Shoreline (Site 101 and shoreline areas of Site 103)

1. **Are the rock shelf areas and stairways being maintained?**
☒ Yes ☐ No
Remarks: *Regular inspection and repairs. During this site walk, observed small area of erosion at south end of the pocket beach near stairs and some missing riprap near wooden stair set.*

2. **Is the seawall being maintained?**
☒ Yes ☐ No
Remarks: _____

3. **Is the armor stone revetment and associated stairways being maintained?**
☒ Yes ☐ No
Remarks:

4. **Is the storm drainage system (catch basin, berm, swale, French drain, riprap slash pads) functioning to prevent erosion of the beaches?**
☒ Yes ☐ No
Remarks: *Some minor repairs required at top of armor stone revetment over time because of erosion from concentrating overland flow.*

5. **Are shellfish harvesting restriction signs present?**
☒ Yes ☐ No
Remarks: *Improved signs installed to prevent breakage.*

D. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs properly implemented ☒ Yes ☐ No
Site conditions imply ICs being fully enforced ☒ Yes ☐ No

Type of monitoring (*e.g.*, self-reporting, drive by): *self reporting*
Frequency: *Annual*
Responsible party *NAVFAC NW*
Contact *Douglas Thelin* (Name) *RPM* (Title) *360.396.0206* (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No
Specific requirements in decision documents have been met ☒ Yes ☐ No
Violations have been reported ☐ Yes ☒ No
Other problems or suggestions; ☐ Report attached:

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: _____

VI. REMEDY COMPONENTS

A. Areas of Soil Cover and Asphalt Paving (Sites 103, 110, and 101-A)

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
   Areal extent_____ Depth_____
   Remarks: _____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks:

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
   Areal extent_____ Depth_____
   Remarks: _____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
   ☒ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks: *Some minor invasive species present at time of review. Invasive species are managed through regular removal. Area of trees and salal near pump station did not survive after remedy construction, but action is being postponed until Benzene Release Area construction is completed.*

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
   ☐ Wet areas ☐ Location shown on site map Areal extent_____
   ☐ Ponding ☐ Location shown on site map Areal extent_____
   ☐ Seeps ☐ Location shown on site map Areal extent_____
   ☐ Soft subgrade ☐ Location shown on site map Areal extent_____
   Remarks: _____

B. Shoreline Stabilization

1. **Seawall & Revetment** ☒ Location shown on site map ☐ Erosion not evident
   Areal extent *2 feet square, multiple* Depth *Shallow*
   Remarks: *Overland stormwater flow concentrating at top of rock revetment at Site 103 has caused several areas of localized erosion that have been repaired as they occurred with gravel fill.*

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   ☒ Vegetation is healthy and preventing erosion
   Areal extent_____ Type_____
   Remarks:

3. **Beach Maintenance (pocket beach area)** ☒ Location shown on site map
   ☐ Erosion not evident
   Areal extent *20 feet square* Depth *12-inch scarp*
   Remarks: *North of stairs and riprap at transition to south end of pocket beach*

4. **Storm Drainage System** ☐ Location shown on site map ☒ Functioning ☐ N/A
   Remarks: _____

C. Groundwater, Seep, and Shellfish Monitoring

1. **Monitoring Wells**
   ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
   ☒ All required wells located ☐ Needs Maintenance ☐ N/A
   Remarks: *Per recent monitoring reports.*

2. **Monitoring**
   Types of monitoring being conducted:
   ☐ Groundwater (Site 110) ☒ Seeps (shoreline areas) ☒ Shellfish
   Frequency:
   Remarks: *See 5-Year review report narrative*

3. **Data Trends**
   Describe results and trends: *See 5-Year review report narrative.*

E. Other Remedy Components

1. **Soil excavations** ☒ Completed ☐ Not Completed
2. **ORC injected into soils at Benzene Release Area** ☒ Completed ☐ Not Completed
3. **Elwood Point pilings removed** ☒ Completed ☐ Not Completed

VII. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

See narrative of five-year review.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

See narrative of five-year review.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

See narrative of five-year review; no cost/scope issues

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

See narrative of five-year review.

APPENDIX B
Interview Responses

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Jackson Park Housing Complex/Naval Hospital Bremerton
Bremerton, Washington

Individual Contacted: Karan Holmes
Title: Remedial Technical Manager
Organization: NAVFAC NW
Telephone: 360-396-0080
E-mail: karan.holmes@msn.com
Address: 1101 Tautog Circle, Silverdale, WA 98315

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
Date: October 20, 2009

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Jackson Park Housing Complex/Naval Hospital Bremerton, the Records of Decision (ROD) for OU 1, the implementation of the remedies at this OU, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: As Environmental Manager at the Naval Hospital Bremerton from 1994 until 2001 and Remedial Project Manager at Naval Facilities Engineering Command, Northwest from 2001 until present I have a high degree of familiarity with the OU1 remedial design and installation. My degree of familiarity with monitoring and maintenance is limited as I was involved with those aspects only until approximately 2004. In 2004 responsibility for monitoring and maintenance functions were transferred to another remedial project manager in our office. Since 2004 I have not had any direct involvement with the OU1 remedies.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy for the four sites that comprise OU 1? For reference, the remedy components included:
   - Covering of surface soils with concentrations above remedial goals in non-residential areas;
   - Excavation of surface soils in backyards where concentrations exceeded remedial goals;

- Excavation of petroleum-impacted soils where concentrations were above remedial goals and the impacted soil was above the seasonal high-water table in the benzene release area;
- Shoreline stabilization measures;
- Removal of old pilings at Elwood Point
- Long-term monitoring (groundwater, seeps, shellfish)
- Institutional controls/ Land use restrictions

Response: Generally the on-going effectiveness of the OU1 remedy is adequate. Specifically, excavation of backyard soils where concentrations exceeded remedial goals, shoreline stabilization measures, excavation of petroleum-impacted soils, piling removals, long-term monitoring, land use restrictions and the soil cover with indicator layer continue to be effective. I do not have sufficient information to determine whether institutional controls are adequately effective.

3. Are you aware of any violations of the institutional controls requirements at any of the sites within OU 1 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: I am not aware of any violations of institutional controls requirements at OU1 with the potential to impact the protectiveness of the remedy.

4. To the best of your knowledge, are regular inspections of the institutional controls remedy components for OU 1 being conducted and documented?

   Response: I do not have sufficient information to determine whether institutional controls are being regularly inspected.

5. To the best of your knowledge, has the on-going environmental monitoring performed at OU 1 since June 2004 been sufficiently thorough and frequent to meet the goals of the ROD? Have the monitoring data been timely and of acceptable quality?

   Response: I do not have sufficient information to determine whether the on-going environmental monitoring performed at OU1 since June 2004 has been sufficiently thorough or frequent to meet goals stated in the ROD.

6. Do you know of any significant operation and maintenance difficulties with the shoreline stabilization components of the OU 1 remedy that could have impacted the protectiveness of this component of the remedy?

Response: I am not aware of any significant operations and maintenance problems with the shoreline stabilization component of the remedy that would impact remedy protectiveness.

7. What is your overall impression of progress to a revised remedy in the benzene release area?

   Response: My overall impression of progress to revise the remedy at the benzene release area is that the Navy is diligently working to address the release area in a timely manner and within Navy program and policy requirements.

8. Are you aware of any community concerns regarding implementation of the remedy at OU 1? If so, please give details.

   Response: I am not aware of any community concerns about the OU1 remedy.

9. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at Jackson Park Housing Complex?

   Response: No.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Jackson Park Housing Complex/Naval Hospital Bremerton
Bremerton, Washington

Individual Contacted: Dwight Leisle
Title: RPM for JPHC OU 2
Organization: NAVFAC NW
Telephone: 360-396-0935
E-mail: Dwight.Leisle@navy.mil
Address: 1101 Tautog Circle, Silverdale, WA 98315

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
Date: October 20, 2009

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Jackson Park Housing Complex/Naval Hospital Bremerton, the Records of Decision (ROD) for OU 1, the implementation of the remedies at this OU, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: I have been the RPM for JPHC OU 2 since February 2008. I am familiar with the OU 1 ROD and the implementation of the remedies at this OU. I am also familiar with the monitoring and maintenance since implementation of the remedies.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy for the four sites that comprise OU 1? For reference, the remedy components included:
   - Covering of surface soils with concentrations above remedial goals in non-residential areas;
   - Excavation of surface soils in backyards where concentrations exceeded remedial goals;
   - Excavation of petroleum-impacted soils where concentrations were above remedial goals and the impacted soil was above the seasonal high-water table in the benzene release area;
   - Shoreline stabilization measures;

- Removal of old pilings at Elwood Point
- Long-term monitoring (groundwater, seeps, shellfish)
- Institutional controls/ Land use restrictions

Response: The components of the OU 1 remedy appear to continue to be protective of human health and the environment.

3. Are you aware of any violations of the institutional controls requirements at any of the sites within OU 1 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: No.

4. To the best of your knowledge, are regular inspections of the institutional controls remedy components for OU 1 being conducted and documented?

   Response: Yes.

5. To the best of your knowledge, has the on-going environmental monitoring performed at OU 1 since June 2004 been sufficiently thorough and frequent to meet the goals of the ROD? Have the monitoring data been timely and of acceptable quality?

   Response: Yes and Yes.

6. Do you know of any significant operation and maintenance difficulties with the shoreline stabilization components of the OU 1 remedy that could have impacted the protectiveness of this component of the remedy?

   Response: No.

7. What is your overall impression of progress to a revised remedy in the benzene release area?

   Response: None.

8. Are you aware of any community concerns regarding implementation of the remedy at OU 1? If so, please give details.

   Response: No.

9. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at Jackson Park Housing Complex?

   Response: See response to question 2.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Jackson Park Housing Complex/Naval Hospital Bremerton
Bremerton, Washington

Individual Contacted: Robert Mitchell
Title: Environmental Manager
Organization: Naval Hospital Bremerton
Telephone: 360-475-4710
E-mail: Robert.mitchell2@med.navy.mil
Address: Code 09PWE
Naval Hospital Bremerton
1 Boone Rd
Bremerton, WA 98312

Contact made by: Deborah Wilson, URS
Response type: Interview Form
Date: October 27, 2009

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Jackson Park Housing Complex/Naval Hospital Bremerton, the Records of Decision (ROD) for OU 1, the implementation of the remedies at this OU, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: I'm familiar with the OU1 ROD as it pertains to the Naval Hospital Bremerton compound. The hospital has a land use control plan in place to ensure ROD requirements are followed. I have been at NHB since 2001 and Environmental Manager since 2006.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy for the four sites that comprise OU 1? For reference, the remedy components included:
   - Covering of surface soils with concentrations above remedial goals in non-residential areas;
   - Excavation of surface soils in backyards where concentrations exceeded remedial goals;

- Excavation of petroleum-impacted soils where concentrations were above remedial goals and the impacted soil was above the seasonal high-water table in the benzene release area;
- Shoreline stabilization measures;
- Removal of old pilings at Elwood Point
- Long-term monitoring (groundwater, seeps, shellfish)
- Institutional controls/ Land use restrictions

Response: There have been no issues or concern for any area on NHB compound.

3. Are you aware of any violations of the institutional controls requirements at any of the sites within OU 1 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: None

4. To the best of your knowledge, are regular inspections of the institutional controls remedy components for OU 1 being conducted and documented?

   Response: All inspections are conducted through NAVFAC.

5. To the best of your knowledge, has the on-going environmental monitoring performed at OU 1 since June 2004 been sufficiently thorough and frequent to meet the goals of the ROD? Have the monitoring data been timely and of acceptable quality?

   Response: I have not been notified of any unacceptable issues or concerns for NHB.

6. Do you know of any significant operation and maintenance difficulties with the shoreline stabilization components of the OU 1 remedy that could have impacted the protectiveness of this component of the remedy?

   Response: None

7. What is your overall impression of progress to a revised remedy in the benzene release area?

   Response: The benzene release area does not affect the NHB area. I have no involvement.

8. Are you aware of any community concerns regarding implementation of the remedy at OU 1? If so, please give details.

   Response: None

9. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at Jackson Park Housing Complex?

   Response: All remedies seem to be in place and functioning as designed. Have had no notification on any issues.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Jackson Park Housing Complex/Naval Hospital Bremerton
Bremerton, Washington

Individual Contacted: Douglas Thelin
Title: Remedial Project Manager
Organization: NAVFAC NW
Telephone: 360-396-0206
E-mail: douglas.thelin@navy.mil
Address: 1101 Tautog Circle, Silverdale, WA 98315

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
Date: October 9, 2009

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Jackson Park Housing Complex/Naval Hospital Bremerton, the Records of Decision (ROD) for OU 1, the implementation of the remedies at this OU, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: I have been the remedial project manager for OU1 since 2004 and therefore responsible for monitoring and maintenance of the remedies since then.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy for the four sites that comprise OU 1? For reference, the remedy components included:
   - Covering of surface soils with concentrations above remedial goals in non-residential areas;
   - Excavation of surface soils in backyards where concentrations exceeded remedial goals;
   - Excavation of petroleum-impacted soils where concentrations were above remedial goals and the impacted soil was above the seasonal high-water table in the benzene release area;
   - Shoreline stabilization measures;
   - Removal of old pilings at Elwood Point

- Long-term monitoring (groundwater, seeps, shellfish)
- Institutional controls/ Land use restrictions

Response: Covering of surface soils in non-residential areas and shoreline stabilization efforts: These measures have been effective with maintenance. No contaminated soil has been released, maintenance has been needed to repair soil covers after heavy rains and replace rocks, removed by residents, protecting the toe of the shoreline protection.

Long-term monitoring: Effective

Institutional Controls/Land use restrictions: These have been effective at preventing exposure to contaminated media at OU1.

3. Are you aware of any violations of the institutional controls requirements at any of the sites within OU 1 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: I am not aware of any institutional controls violations at OU1.

4. To the best of your knowledge, are regular inspections of the institutional controls remedy components for OU 1 being conducted and documented?

   Response: Institutional control remedy component inspections are conducted annually and documented using checklists from the OU1 Land Use Control Plan. Additionally, the Navy has a contractor perform quarterly and semi-annual inspections of the remedy components, any violations of the institutional controls would be included in the reports from these periodic inspections.

5. To the best of your knowledge, has the on-going environmental monitoring performed at OU 1 since June 2004 been sufficiently thorough and frequent to meet the goals of the ROD? Have the monitoring data been timely and of acceptable quality?

   Response: Monitoring data has been timely and of acceptable quantity with the exception of ordnance compounds in marine tissue. There were a few detections of RDX in tissue in 2002 and 2004 but due to method limitations it is unclear if the detections were false positives or actually indicated the presence of RDX.

   The OU1 monitoring has been sufficiently thorough and frequent. Consideration should be given to reducing the suite of analytes tested for as recommended in the Summer 2008 Long-Term Monitoring Report. The need for future marine tissue sampling also needs to be examined.

6. Do you know of any significant operation and maintenance difficulties with the shoreline stabilization components of the OU 1 remedy that could have impacted the protectiveness of this component of the remedy?

   Response: The two problems experienced with the shoreline stabilization have been the residents removing rocks protecting the toe of the shoreline protection for recreational uses and minor erosion occurring during heavy rains. We have been able to counter the erosion by placing new material, our contractor spends too much time replacing rock removed by the residents.

7. What is your overall impression of progress to a revised remedy in the benzene release area?

   Response: None

8. Are you aware of any community concerns regarding implementation of the remedy at OU 1? If so, please give details.

   Response: During the periodic Jackson Park site Restoration Advisory Board meetings, no more than one or two community members attend.

9. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at Jackson Park Housing Complex?

   Response: None

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Jackson Park Housing Complex/Naval Hospital Bremerton
Bremerton, Washington

Individual Contacted: Dianne Vogel
Title: Remedial Program Manager, Environmental Coordinator and Customer Relations Coordinator
Organization: NAVFAC NW
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Contact made by: Deborah Wilson, URS
Response type: Telephone interview
Date: October 30, 2009

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Jackson Park Housing Complex/Naval Hospital Bremerton, the Records of Decision (ROD) for OU 1, the implementation of the remedies at this OU, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: I am very familiar; I am the restoration advisory board chair.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy for the four sites that comprise OU 1? For reference, the remedy components included:
   - Covering of surface soils with concentrations above remedial goals in non-residential areas;
   - Excavation of surface soils in backyards where concentrations exceeded remedial goals;
   - Excavation of petroleum-impacted soils where concentrations were above remedial goals and the impacted soil was above the seasonal high-water table in the benzene release area;
   - Shoreline stabilization measures;
   - Removal of old pilings at Elwood Point

- Long-term monitoring (groundwater, seeps, shellfish)
- Institutional controls/ Land use restrictions

Response: The RPM's work very hard to ensure the remedies are effective.

3. Are you aware of any violations of the institutional controls requirements at any of the sites within OU 1 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: No.

4. To the best of your knowledge, are regular inspections of the institutional controls remedy components for OU 1 being conducted and documented?

   Response: Yes.

5. To the best of your knowledge, has the on-going environmental monitoring performed at OU 1 since June 2004 been sufficiently thorough and frequent to meet the goals of the ROD? Have the monitoring data been timely and of acceptable quality?

   Response: Yes.

6. Do you know of any significant operation and maintenance difficulties with the shoreline stabilization components of the OU 1 remedy that could have impacted the protectiveness of this component of the remedy?

   Response: The only thing is this is a living base, we have families that live there and sometimes it's hard to get the teenagers to comply. Sometimes we have a little vandalism, usually of the signs.

7. What is your overall impression of progress to a revised remedy in the benzene release area?

   Response: The RPM is working diligently to ensure that the remedy is in place.

8. Are you aware of any community concerns regarding implementation of the remedy at OU 1? If so, please give details.

   Response: None at the moment.

9. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at Jackson Park Housing Complex?

   Response: None at this time.

INTERVIEW RECORD FOR SECOND FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Jackson Park Housing Complex/Naval Hospital Bremerton
Bremerton, Washington

Individual Contacted: Leslie Yuenger
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Contact made by: Deborah Wilson, URS
Response type: Written, by email.
Date: October 8, 2009

Summary of Communication

You are not obligated to answer every question. If you are not familiar with the topic of a particular question, or have no information or opinion to offer, please indicate "none" after "response."

1. Please describe your degree of familiarity with the Jackson Park Housing Complex/Naval Hospital Bremerton, the Records of Decision (ROD) for OU 1, the implementation of the remedies at this OU, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: Having been associated with facility responsibilities for Jackson Park Housing Complex area since 1989, I am aware of the ROD for OU1, the implementation remedies and the monitoring and maintenance that has taken place since the implementation of these remedies. In November 2006, in taking the position of PAO, I review all documents prior to their release to the public. I attend the RAB meetings, whenever held.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy for the four sites that comprise OU 1? For reference, the remedy components included:
   - a. Covering of surface soils with concentrations above remedial goals in non-residential areas;
   - b. Excavation of surface soils in backyards where concentrations exceeded remedial goals;

- c. Excavation of petroleum-impacted soils where concentrations were above remedial goals and the impacted soil was above the seasonal high-water table in the benzene release area;
- d. Shoreline stabilization measures;
- e. Removal of old pilings at Elwood Point
- f. Long-term monitoring (groundwater, seeps, shellfish)
- g. Institutional controls/ Land use restrictions

Response: a. Successful.
b. Successful.
c. Successful.
d. Somewhat successful, but natural tidal action has adversely affected the soil cap and has had to be replaced. The natural slope continues to degrade.
e. Successful. Completely removing the pilings prevents boaters from tying up to them.
f. Successful.
g. Barely successful. This is a family housing area, children, pets, and inattentive parents largely chose to ignore land use restrictions, they go where they want, they dig in the sand where they want and chose to ignore the restrictions. (They also cut wire fencing where they want.)

3. Are you aware of any violations of the institutional controls requirements at any of the sites within OU 1 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: No.

4. To the best of your knowledge, are regular inspections of the institutional controls remedy components for OU 1 being conducted and documented?

   Response: Yes.

5. To the best of your knowledge, has the on-going environmental monitoring performed at OU 1 since June 2004 been sufficiently thorough and frequent to meet the goals of the ROD? Have the monitoring data been timely and of acceptable quality?

   Response: Yes.

6. Do you know of any significant operation and maintenance difficulties with the shoreline stabilization components of the OU 1 remedy that could have impacted the protectiveness of this component of the remedy?

Response: Yes, natural tidal action. However, nearly impossible to contain without removing the entire shoreline back to the natural cliffs.

7. What is your overall impression of progress to a revised remedy in the benzene release area?

   Response: Seems like a sensible revision, given the ongoing issue.

8. Are you aware of any community concerns regarding implementation of the remedy at OU 1? If so, please give details.

   Response: In the last two RABs, community attendance has caused the RAB to consider canceling them. One couple who thought that it was a different meeting attended the first one. A spouse, who happened to be a scientist, attended the second one, she came out of curiosity, and had no issue with the information presented.

9. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at Jackson Park Housing Complex?

   Response: No.