FINAL
8 December 2010

Third Five-Year Review

Naval Base Kitsap
Keyport, 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 Naval Base Kitsap (NBK) Keyport, Washington, the U.S. Navy has completed the third 5-year review of the remedial actions at Operable Unit 1 (OU 1) and OU 2 conducted pursuant to Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). The purpose of this 5-year review is to ensure that the remedial actions selected in the Records of Decision (ROD) for OU 1 and OU 2 at NBK Keyport 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 third 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*, November 2001 (Revised May 2004) and the U.S. Environmental Protection Agency's *Comprehensive Five-Year Review Guidance* (OSWER 9355.7-03B-P, June 2001).

The remedies at OU 1 and OU 2 were implemented and have been operating for at least a decade (10 years of operation at OU 1 and 15 years of operation for OU 2). Components of the remedies for OU 1 and OU 2 are functioning as intended by the RODs. However, some concerns have been identified as a result of this third 5-year review, which identifies issues and follow-up recommendations that address potential problems and uncertainties.

Concentration trends are slightly downward for most chemicals of concern (COCs) in most media at most monitoring locations, indicating modest progress towards meeting remedial action objectives. Natural attenuation processes are functioning to reduce COC concentrations, while exposures are prevented by institutional controls. COC concentration trends are tracked and evaluated through regular monitoring. At OU 1, phytoremediation has not been as effective as originally anticipated when it was evaluated during remedy selection, and 1,4-dioxane is present in groundwater beneath OU 1 and OU 2 Area 8 at concentrations exceeding the current Model Toxics Control Act Method B cleanup level. There is uncertainty as to why cadmium concentrations in sediment are trending slowly upward. Additional monitoring to assess COC trends in sediment and clam tissue and additional ecological and human health risk assessments are warranted.

The remedy implemented at OU 1 is expected to be protective of human health and the environment in the future, once intrinsic bioremediation, with possible assistance from phytoremediation, degrades contaminant concentrations to below remediation goals. In the interim, exposure pathways that could result in unacceptable risks are being controlled and monitored.

An overall protectiveness determination of the remedy at OU 2 cannot be made at this time because the OU 2 Area 8 protectiveness determination needs to be deferred. The remedy implemented at OU 2 Area 2 is expected to be protective of human health and the environment in the future, once natural attenuation degrades contaminant concentrations to below remediation goals. In the interim, exposure pathways that could result in unacceptable risks are being controlled and monitored.

A protectiveness determination of the remedy at OU 2 Area 8 cannot be made at this time and will be deferred until further information is obtained. Further information will be obtained by implementing recommendations 9 and 10 in Table 8-1.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Naval Undersea Warfare Engineering Station (4 Waste Areas)		
EPA ID *(from WasteLAN)*: WA1170023419		
Region: 10	**State:** WA	**City/County:** Keyport/Kitsap
SITE STATUS		
NPL status: Final **X** Deleted Other (specify)_____		
Remediation status (choose all that apply): Under Construction Operating **X** Complete **X**		
Multiple OUs?* YES **X** NO	**Construction completion date:** 06/27/2000 (OU 1)	
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 NW – U.S. Navy	
Review period:** June 2004 to June 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: **3** (Third)		
Triggering action: Actual RA Onsite Construction at OU 1 Actual RA Start at OU 1 Construction Completion Previous Five-Year Review Report Other (specify):_____		
Triggering action date *(from WasteLAN)*: December 2005		
Due date *(five years after triggering action date)*: December 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 (Cont.)

Issues:

Site-Wide

- The basis for some remediation goals (RGs) at the site, including both applicable or relevant and appropriate requirements (ARARs) and toxicity criteria, have changed and continue to change, with the potential to affect future decisions regarding monitoring and institutional controls requirements.
- There are infrequent community updates.

OU 1

- Phytoremediation at Operable Unit 1 (OU 1) is not as effective as intended by the Record of Decision (ROD).
- 1,4-Dioxane is present in shallow-aquifer and intermediate-aquifer groundwater at concentrations exceeding the current Model Toxics Control Act (MTCA) Method B Cleanup level at OU 1.
- The data set generated to date indicates that changes to the OU 1 monitoring program may be warranted.
- The chromium concentration in the 2009 sediment sample from location MA-11 was higher than typically observed and exceeded the screening level for the first time since 1996.

OU 2 Area 2

- Based on the data set generated to date, changes to the groundwater monitoring program may be warranted.
- The current lowest possible practical quantitation limit for vinyl chloride in groundwater (0.02 µg/L using selected ion monitoring analysis) is not being met by the monitoring program.

OU 2 Area 8

- 1,4-Dioxane is present in one groundwater monitoring well at OU 2 Area 8 at concentrations exceeding the current MTCA Method B cleanup level.
- Cadmium concentrations in sediment appear to be slowly increasing at OU 2 Area 8.

Recommendations and Follow-up Actions:

Site-Wide

- In the next revision of long-term monitoring (LTM) plan and institutional controls management plan, include language that states that the basis of the remediation goal (i.e., ARARs, practical quantitation limits [PQLs], and risk assessment assumptions) must be reviewed prior to any change in monitoring or institutional controls requirements.
- Evaluate ways to improve updates to the community.

OU 1

- Perform the evaluation of natural attenuation and intrinsic bioremediation called for in Section 11.1.6 of the ROD.
- Add 1,4-dioxane as an analyte for groundwater wells sampled for evaluation under the contingent remedial action (CRA) plan. Revise the CRA plan to incorporate trigger levels for 1,4-dioxane in sentinel wells.

Five-Year Review Summary Form (Cont.)

- In conjunction with the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), and the Suquamish Tribe, revise the LTM plan for OU 1.

- In conjunction with EPA, Ecology, and the Suquamish Tribe, develop a sampling and analysis plan (SAP) to assess chromium concentrations in sediment around location MA-11, including an assessment of chromium concentrations in catch basin solids.

OU 2 Area 2

- Revise the LTM plan to address potential changes to monitoring.
- Use selected ion monitoring analysis to achieve a PQL of 0.02 µg/L for vinyl chloride in water samples.

OU 2 Area 8

- Include 1,4-dioxane in the analyte list for groundwater and seep samples during the 2011 LTM sampling event. Evaluate the need for additional monitoring or action related to 1,4-dioxane based on 2011 results.
- In conjunction with EPA, Ecology, and the Suquamish Tribe, prepare a SAP for sediment and marine tissue at OU 2 Area 8 and perform an additional ecological risk evaluation and human health risk assessment based on the results of the sampling.

Protectiveness Statement(s):

The remedy implemented at OU 1, NBK Keyport, is expected to be protective of human health and the environment in the future once intrinsic bioremediation, with possible assistance from phytoremediation, degrades contaminant concentrations to below RGs. In the interim, exposure pathways that could result in unacceptable risks are being controlled and monitored. The conditions and chemical of concern (COC) concentrations found today in the landfill, marsh, and downstream receptors are similar to those at the time of the ROD, when those conditions were found to not pose unacceptable risks to human health and the environment, as long as exposures were controlled. Current protectiveness should be verified through assessment of chromium concentrations in sediment near location MA-11 to ensure that the chromium concentrations in sediment at this location do not represent discharge conditions different than known at the time of the ROD. Future protectiveness depends on implementing the recommendations of this review and will be assessed based on continued monitoring of COC concentrations and trend analysis.

An overall protectiveness determination of the remedy at OU 2 cannot be made at this time because the OU 2 Area 8 protectiveness determination needs to be deferred. The remedy implemented at OU 2 Area 2, is expected to be protective of human health and the environment in the future, once natural attenuation degrades contaminant concentrations to below RGs. In the interim, exposure pathways that could result in unacceptable risks are being controlled and monitored. The conditions and COC concentrations found today in groundwater are similar to those at the time of the ROD, when those conditions were found to not pose unacceptable risks to human health and the environment, as long as exposures were controlled. Future protectiveness depends on implementing the recommendations of this review (Table 8-1) and will be assessed based on continued monitoring of COC concentrations and trend analysis.

Five-Year Review Summary Form (Cont.)

A protectiveness determination of the remedy at OU 2 Area 8 cannot be made at this time and will be deferred until further information is obtained. Further information will be obtained by implementing recommendations 9 and 10 in Table 8-1, which call for including analysis of 1,4-dioxane in the 2011 monitoring plan, the development of a sediment and marine tissue SAP, sampling to generate new data, and further evaluation of potential sediment and marine tissue contamination and risk assessment. Based on the time required to develop a SAP, collect and analyze data, and conduct a risk evaluation, a protectiveness determination is not expected to be made until December 31, 2014.

Other Comments: None

Signature sheet for the Naval Base Kitsap Keyport Third Five-Year Review report.

CAPT, USN

30 Dec '10

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

Date

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ABBREVIATIONS AND ACRONYMS

AET	apparent effects threshold
ARAR	applicable or relevant and appropriate requirement
ASIL	acceptable source impact level
AVS/SEM	acid-volatile sulfide and simultaneously extracted metals
AWQC	ambient water quality criteria
bgs	below ground surface
BHC	benzene hexachloride
CAHs	chlorinated aliphatic hydrocarbons
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COI	chemical of interest
COPEC	chemical of potential ecological concern
CRA	contingent remedial action
CR(VI)	chromium VI
DCA	dichloroethane
DCE	dichloroethene
DDE	dichlorodiphenyldichlorethene
DDT	dichlorodiphenyltrichloroethane
DNAPL	dense nonaqueous-phase liquid
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERE	ecological risk evaluation
ESD	Explanation of Significant Difference
FFA	federal facilities agreement
FS	feasibility study
g/day	gram per day
HI	hazard index
HQ	hazard quotient
IAS	initial assessment study
IRIS	Integrated Risk Information System
LTM	long-term monitoring
MATC	maximum acceptable tissue concentration
MCL	maximum contaminant level
µg/kg	microgram per kilogram
µg/L	microgram per liter
mg/kg	milligram per kilogram

ABBREVIATIONS AND ACRONYMS (Continued)

mg/kg-day	milligram per kilogram per day
msl	mean sea level
MTCA	Model Toxics Control Act
MW	monitoring well
Navy	U.S. Navy
NAVFAC NW	Naval Facilities Engineering Command Northwest
NBK	Naval Base Kitsap
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OEHHA	Office of Environmental Health Hazard Assessment (State of California)
O&M	operation and maintenance
OM&M	operation, maintenance, and monitoring
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PQL	practical quantitation limit
PSAMP	Puget Sound Assessment and Monitoring Program
PSCAA	Puget Sound Clean Air Agency
PSDDA	Puget Sound dredged disposal analysis
PSEP	Puget Sound Estuary Program
PUD	Public District Utility (Kitsap County)
RAB	Restoration Advisory Board
RAO	remedial action objective
redox	oxidation reduction
RfD	reference dose
RG	remediation goal
RI	remedial investigation
ROD	Record of Decision
SIM	selected ion monitoring
SLERA	screening-level ecological risk assessment
SQS	sediment quality standard
SVOC	semivolatile organic compound
TCA	trichloroethane
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TRC	Technical Review Committee
USGS	U.S. Geological Survey

ABBREVIATIONS AND ACRONYMS (Continued)

UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code

1.0 INTRODUCTION

This report presents the results of the third 5-year review performed for the Naval Base Kitsap (NBK) Keyport National Priorities List (NPL) site (Figure 1-1). The purpose of a 5-year review is to determine whether the remedies selected for implementation in the Record of Decision (ROD) for a site are 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 cleanup at NBK Keyport, 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.

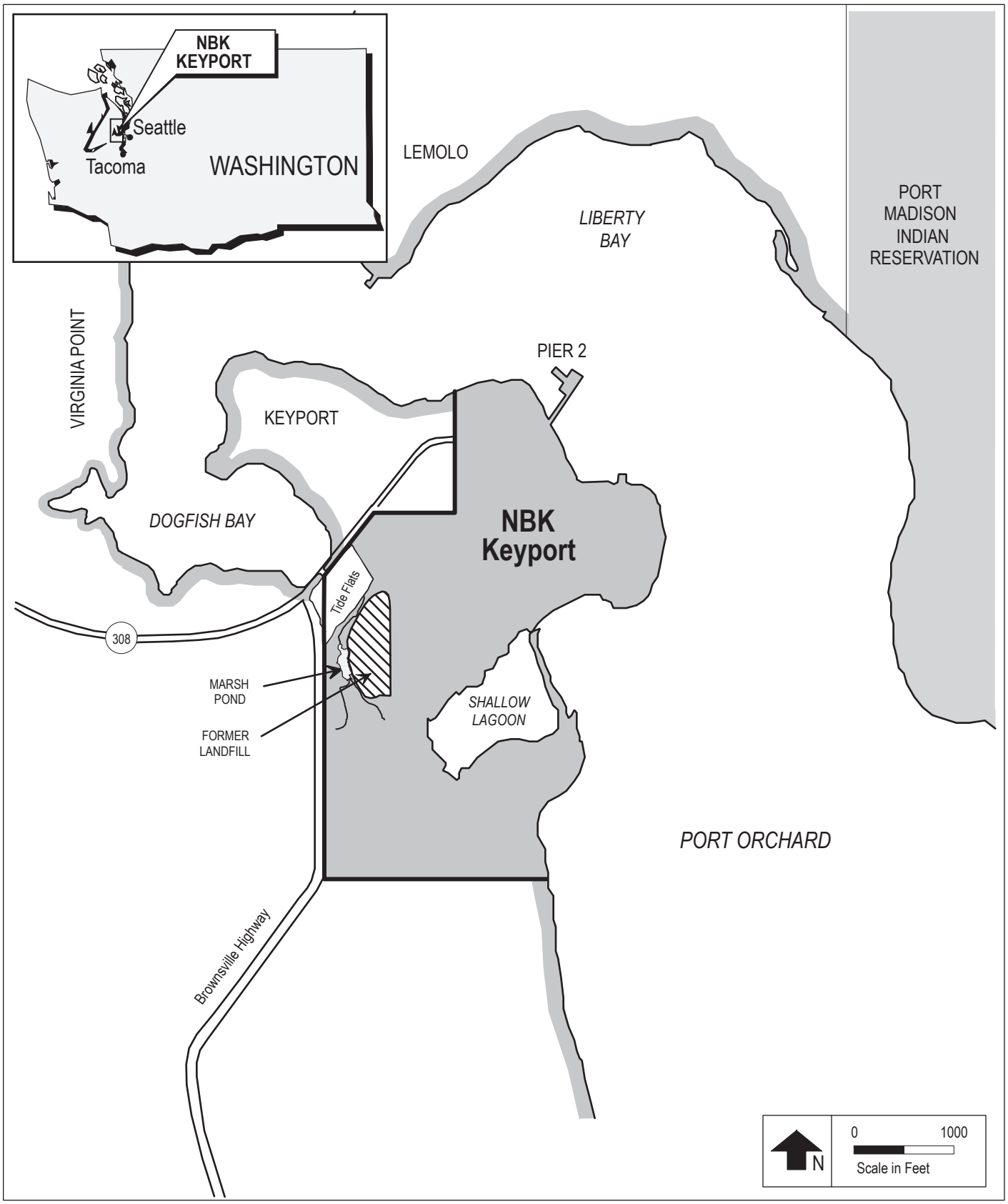
The Naval Facilities Engineering Command Northwest (NAVFAC NW) has conducted this 5-year review of the remedial actions implemented at NBK Keyport. This review was conducted from June 2009 through March 2010, and this report documents the results of the review. The lead regulatory agency for cleanup at NBK Keyport is the Washington State Department of Ecology (Ecology).

This report covers the remedies selected in the signed RODs for Operable Unit 1 (OU 1) and OU 2 (U.S. Navy, USEPA, and Ecology 1994 and 1998).

This is the third 5-year review for NBK Keyport. The triggering action for this review was the execution of the second 5-year review by the Navy on June 5, 2005, with an errata sheet pertaining to the second 5-year review executed by the Navy on October 27, 2005. Contaminants have been left at NBK Keyport above levels that allow for unlimited use and unrestricted exposure.

The RODs documenting the remedies implemented at NBK Keyport OU 1 and OU 2 were signed after October 17, 1986. Therefore, this is considered a statutory, rather than a policy, review.

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



U.S. NAVY	Figure 1-1 NBK Keyport Vicinity Map	NBK Keyport THIRD FIVE-YEAR REVIEW

2.0 SITE CHRONOLOGY

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

In September 1984, the Navy conducted an initial assessment study (IAS), under the Navy Assessment and Control of Installation Pollutants program, to identify areas of possible environmental contamination resulting from past methods of storage, handling, and disposal of hazardous substances at NBK Keyport (U.S. Navy 1984). In October 1989, NBK Keyport was officially listed on the NPL. In response to the NPL designation, the Navy, EPA, and Ecology entered into an interagency federal facilities agreement (FFA) in July 1990 for the investigation, remediation, and restoration of the site.

Subsequent to the IAS, six specific areas (Areas 1, 2, 3, 5, 8, and 9) were recommended for further investigation in the remedial investigation/feasibility study (RI/FS). Under the Environmental Restoration Program, the RI/FS process for these six areas began in 1988, and the final RI/FS reports were submitted in October and November of 1993 (U.S. Navy 1993). During the public comment period for the proposed plan, significant public concerns were identified regarding Area 1 (the former base landfill). Therefore, it was determined that the site should be divided into two OUs for efficient administrative handling of the remediation of the site (Figure 2-1). OU 1 consists of Area 1 (the former base landfill), and OU 2 consists of the remaining areas of concerns (Areas 2, 3, 5, 8, and 9).

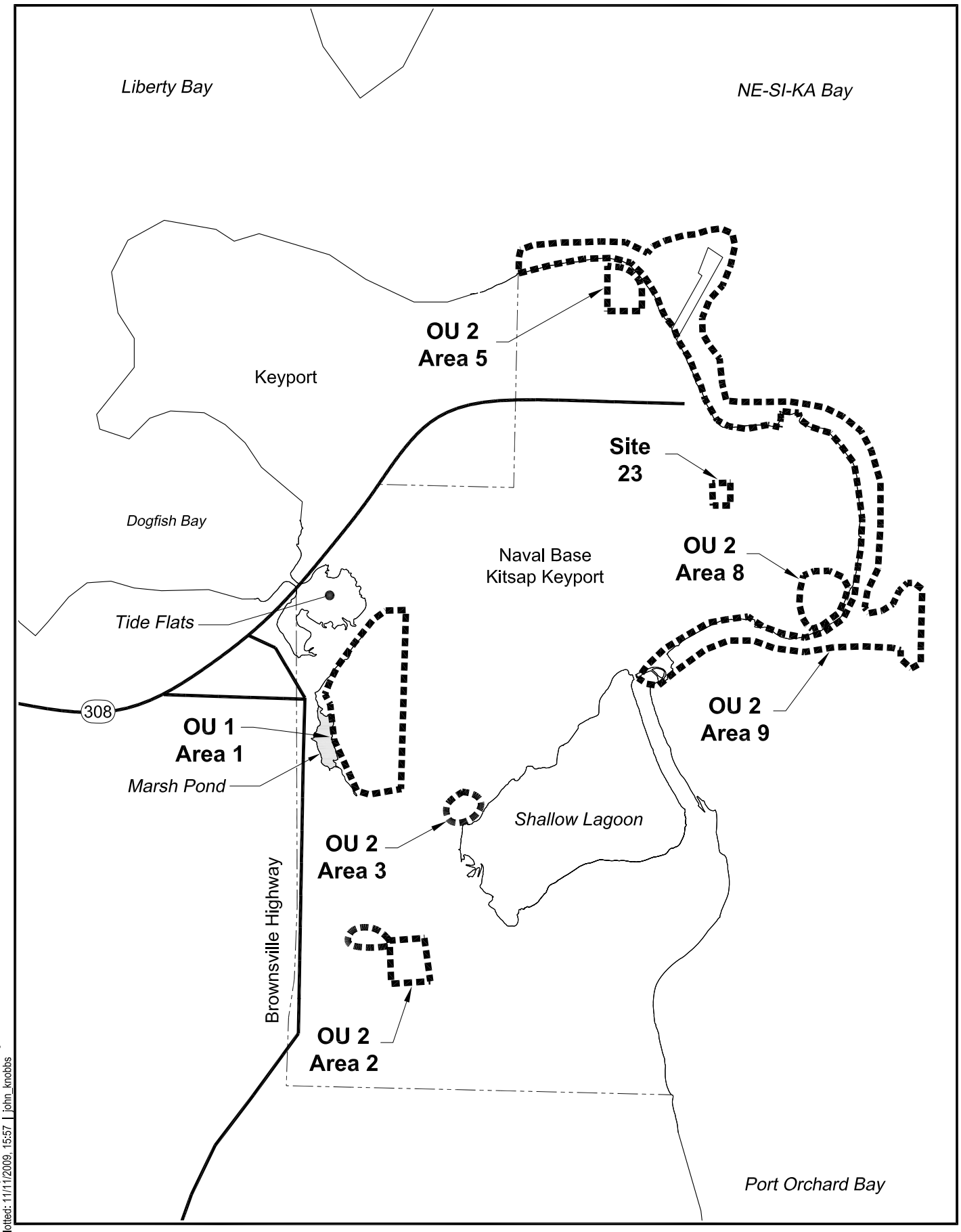
Two separate RODs were prepared for NBK Keyport. The ROD for OU 2 was signed September 28, 1994 (U.S. Navy, USEPA, and Ecology 1994), and the ROD for OU 1 was signed September 30, 1998 (U.S. Navy, USEPA, and Ecology 1998). The ROD for OU 2 was modified by one Explanation of Significant Differences (ESD) dated March 15, 1996 (U.S. Navy, USEPA, and Ecology 1996). The ESD delayed completing soil removal at OU 2 Area 8 until after the plating building was demolished and changed the determination of the amount of soil to be removed to be based on total chromium analyses instead of hexavalent chromium analyses.

After the ROD for OU 2 was approved in September 1994, remedial actions were implemented at the five areas within OU 2 from 1995 through 2000. After remedial actions were completed at Areas 3, 5, and 9, determinations of “no further action” were issued for these areas (U.S. Navy 2000b).

The ROD for OU 1 was signed in September of 1998, and remedial actions occurred from late 1998 through 2003. The final remedy construction element to be completed was upgrading of the landfill pavement, which was completed in December 2003.

The Navy performed a time-critical removal action at Site 23 under CERCLA as a part of the Building 21 demolition. The time-critical removal action was conducted under an Action Memorandum signed in July 1999. Although Site 23 was not included as one of the original sites to be investigated and was not included in the OU 2 ROD, the results of this time-critical removal action were included in the first 5-year review because the removal action was performed under CERCLA (U.S. Navy 2000b). The risks remaining at the site after completion of the time-critical removal action were demonstrated to be protective of human health and the environment with institutional controls (U.S. Navy 2000b). This site was therefore to be added to the institutional controls management plan (U.S. Navy 2000a). This element of the remedy was completed in 2009 with publication of a revised institutional controls management plan (U.S. Navy 2009a).

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



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U.S. NAVY

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Figure 2-1
Locations of OU 1 and OU 2 Areas and Site 23

NBK Keyport
THIRD FIVE-YEAR
REVIEW

Table 2-1
Chronology of Events

Event	Date
Site-wide	
Discovery and preliminary assessment	1984
Placed on National Priorities List	1989
Interagency Agreement[a]	1990
Site-wide remedial investigation/feasibility study	1993
Separation of site into OU 1 and OU 2	1994
First 5-year review	2000
Second 5-year review	2005
OU 1	
ROD for OU 1	1998
Remedy construction complete for OU 1	2003
OU 2	
ROD for OU 2	1994
Explanation of Significant Differences for the OU 2 ROD	1996
Time-critical removal action conducted for Site 23, discovered post-ROD	1999
Remedy construction complete for OU 2	2000
Final closeout report for Site 23	2000

[a]Navy, U.S. Environmental Protection Agency, and Washington State Department of Ecology

Notes:
OU - operable unit
ROD - Record of Decision

3.0 BACKGROUND

NBK Keyport occupies 340 acres (including tidelands) adjacent to the town of Keyport in Kitsap County, Washington, on a small peninsula in the central portion of Puget Sound. The Keyport property was acquired by the Navy in 1913, with property acquisition continuing through World War II. The property was first used as a quiet-water range for torpedo testing. The first range facility was located in Port Orchard Inlet southeast of the site.

During the early 1960s, Keyport's role was expanded to include manufacturing and fabrication such as welding, metal plating, carpentry, and sheet metal work. Further expansion in 1966 consisted of a new torpedo shop, and, in 1978, the functions broadened to include various undersea warfare weapons and systems engineering and development activities. Operations currently include engineering, fabrication, assembly, and testing of underwater weapons systems.

NBK Keyport is bordered by Liberty Bay on the east and north and Port Orchard Inlet on the southeast (Figure 1-1). The topography of the site rises gently from the shoreline to an average of 25 to 30 feet above mean sea level (msl) and then rises steeply to approximately 130 feet above msl at the southeast corner of the site.

Marine or brackish water bodies on and near the site consist of Liberty Bay, Dogfish Bay, the tide flats, a marsh, and the shallow lagoon. Freshwater bodies include two creeks draining into the marsh pond and two creeks that discharge into the shallow lagoon.

The terrestrial soil in the Keyport area generally includes coarse-grained glacial deposits and finer grained nonglacial deposits. Most of NBK Keyport is underlain by a thick nonglacial silt and clay informally known as the Clover Park Unit. This unit is commonly about 100 feet thick and is an aquitard separating the unconfined aquifer above (referred to as the "upper aquifer") and the intermediate aquifer beneath it.

3.1 OPERABLE UNIT 1

OU 1 consists of Area 1, the former base landfill, which comprises approximately 9 acres in the western part of the base next to a wetland area and the tide flats that flow into Dogfish Bay (Figure 3-1). Most of the landfill area was formerly a marshland. The landfill is unlined at the bottom, and the top is covered with areas of grass, trees, and asphalt. The landfill was the primary disposal area for domestic and industrial wastes generated by the base from the 1930s until 1973, when the landfill was closed. A burn pile for trash and demolition debris was located at the north end of the landfill from the 1930s to the 1960s. Unburned or partially burned materials from this pile were buried in the landfill or pushed into the marsh. A trash incinerator

was operated at the north end of the landfill from the 1930s to the 1960s, and incinerator ash was disposed of in the landfill. Burning continued at the landfill until the early 1970s.

During various site investigation and assessment studies between 1984 and 1988, Area 1 was determined to have possible environmental contamination that might impact the environment. An RI/FS was conducted at Area 1 between 1988 and 1993, after which human health and ecological risk assessments were conducted (U.S. Navy 1993). Based on the results of these studies, seven remedial alternatives were evaluated in the FS for Area 1, and the Navy, Ecology, and EPA selected a preferred remedial alternative. This preferred alternative was described in the 1994 proposed plan. Because public comments were not favorable to the preferred remedial alternative, the proposed plan was withdrawn and Area 1 was separated from the other areas to become OU 1.

To address the public's concerns, the Navy, Ecology, and EPA conducted further site characterization to collect data to supplement the RI. Starting in 1995 and ending in September 1996, five quarterly rounds of sampling were conducted. The additional data were used to evaluate the potential risks from the following three key chemical of concern (COC) pathways at OU 1:

- Drinking water
- Seafood ingestion
- Ecological

The environmental media that might have impacted the pathways are groundwater, surface water, and sediment downgradient of OU 1. New data from the site characterizations were discussed and evaluated in the summary data assessment report (U.S. Navy 1997a), which supplemented the RI. A supplemental focused feasibility study then evaluated several additional alternatives, from which a new preferred remedial alternative was selected and eventually accepted, based on public comments. The OU 1 ROD was executed in September 1998.

Based on the original RI and the supplemental data assessment, two classes of contaminants were identified as COCs for the three main potential exposure pathways of interest (see above): chlorinated aliphatic hydrocarbons (CAHs, a class of volatile organic compounds [VOCs]) and polychlorinated biphenyls (PCBs). The VOCs were identified as COCs because of the drinking water and seafood ingestion pathways and PCBs because of their potential to bioaccumulate, possibly impacting the seafood ingestion pathway.

VOCs were found to be present in the upper and intermediate aquifers, with concentrations in the upper aquifer greater than those in the intermediate aquifer by an order of magnitude or more. The VOCs had formed plumes in both aquifers, although field data did not indicate the presence of dense nonaqueous-phase liquid (DNAPL) bodies in either aquifer. Groundwater from the

southern part of the landfill had (and continues to have) the highest concentrations of VOCs, and some VOCs were, and still are, detected in the adjacent surface water, particularly in the marsh downgradient of the landfill. The presence of these compounds in the marsh water appears to be the direct result of ongoing discharge from the upper aquifer into the marsh. Data also indicated that mobile VOC contaminants in the intermediate aquifer would eventually be discharged to surface water in the tide flats or Dogfish Bay.

Current hydrogeologic conditions result in groundwater flow from both the upper and intermediate aquifers into the adjacent surface water and away from areas where drinking water wells exist or could exist in the future.

PCBs were detected in the groundwater of the upper aquifer, seeps, aquatic sediment, and clam tissue samples. PCBs were not detected in the intermediate aquifer. Because the PCBs measured in the seep were discharging directly into the marsh, it was concluded that many of the PCBs migrating from the landfill into the marsh were coming from the seep, instead of from the groundwater where detected PCB levels are low. Although PCB concentrations in the creek sediments were below levels requiring active cleanup, a decision was reached to remove the sediments to prevent future movement into the tideflats and Dogfish Bay via this pathway.

Risk assessments indicated that direct exposure to the COCs within the landfill could cause human health risk above acceptable risk levels.

3.2 OPERABLE UNIT 2

OU 2 consists of the following areas:

- Area 2 – Van Meter Road Spill/Drum Storage Area
- Area 3 – Otto Fuel Leak Area (not subject to 5-year review)
- Area 5 – Sludge Disposal Area (not subject to 5-year review)
- Area 8 – Plating Shop Waste/Oil Spill Area
- Area 9 – Liberty Bay (not subject to 5-year review)

The OU 2 ROD specified that only Areas 2 and 8 are subject to the 5-year review. No further action was selected for Area 3, and confirmation sampling was required at Areas 5 and 9 to determine their eligibility for the 5-year review. Confirmation sampling was conducted at Area 5 for groundwater and at Area 9 for marine sediment in 1995 (U.S. Navy 1996a and 1996b). Results of the confirmation sampling at both areas indicated contamination did not exceed any of the remediation goals (RGs) set for those areas. Therefore, no further action was selected for Areas 5 and 9 in the ROD. The land use continues to be unrestricted at these areas, and, as such, they are not subject to this 5-year review.

3.2.1 Area 2 – Van Meter Road Spill/Drum Storage Area

Area 2 is located in the southwest corner of NBK Keyport (Figure 2-1). It is bounded to the north and east by Westfall Road, to the west by Keys Road, and to the south by a sharp topographic rise representing the southern limit of NBK Keyport. Van Meter Road essentially bisects the area in a north-south direction. Area 2 is composed of three distinct sites: the Van Meter Road spill area, the former Building 734 drum storage area just west of Van Meter Road, and former Building 957 drum storage area immediately east of Van Meter Road (Figure 3-2).

Two unpaved areas associated with the two drum storage areas were active from the 1940s through the 1960s. These two areas were reportedly used to store all chemicals (including solvents and fuel/oil) used at NBK Keyport during this time period. In 1976, approximately 2,000 to 5,000 gallons of plating shop wastes spilled from a tanker truck on the pavement near Van Meter Road and impacted a nearby stream (U.S. Navy 1984). It was estimated that between 4,000 and 8,000 gallons of these chemicals were discharged into the two unpaved areas as a result of spills and leaks (U.S. Navy 1984).

The 1984 IAS identified Area 2 for further investigation in the RI/FS. The RI/FS process for OU 2 began in 1988, and the final RI/FS reports were submitted in October and November of 1993. Media sampled during the Area 2 RI include air, soil, stream sediment, and groundwater. Based on the sampling results, human health and ecological risk assessments were conducted. The ecological risk assessment did not identify any significant risks to terrestrial or aquatic organisms at Area 2. For the drum storage area, the human health risk assessment did not identify any significant risk to current workers. However, it did indicate possible risks to hypothetical future residents at the drum storage area from exposure to soil and groundwater. These risks are primarily associated with trichloroethene (TCE) and vinyl chloride. No significant risk was identified at the Van Meter Road plating shop waste spill.

Based on the risk analyses, other COCs do not present significant additional risk (U.S. Navy, USEPA, and Ecology 1994).

TCE and vinyl chloride were detected in some of the groundwater samples collected from the upper aquifer at levels that exceeded the drinking water standards. Because of the relatively low concentration levels of VOCs in the groundwater, the potential for off-site migration was determined to be low. While levels of the primary COCs exceeded the applicable or relevant and appropriate requirements (ARARs), a decision was reached in the ROD that active measures to remediate the groundwater were not presently appropriate given the low contaminant concentrations, the high cost to remediate such low concentrations, and the ability to effectively preclude future residential use and groundwater use at this area through appropriate institutional controls.

3.2.2 Area 8 – Plating Shop Waste/Oil Spill Area

Area 8 occupies about 1 acre on the eastern portion of NBK Keyport and surrounds the location of the former plating shop (Building 72) (Figures 2-1 and 3-3). Building 72 was demolished in 1999 and replaced by an asphalt-paved parking area. The site is located in a heavily industrialized part of the facility bordered by Liberty Bay to the south and east (Figure 3-3). The area is predominantly flat and almost entirely paved or covered by buildings.

Past releases at Area 8 include spillage of chrome plating solution onto the ground; discharge of plating wastes into a utility trench; and leakage of plating solutions through cracks in the plating shop floor, waste disposal pipes, and sumps. VOCs present in the solvents used in the plating shop were released during plating shop operation. Petroleum hydrocarbons (diesel and heavy oil) were released to the environment from leaky underground storage tanks (USTs) and underground concrete vaults located within Area 8.

Area 8 was investigated and characterized together with other areas during the IAS and RI/FS. In addition, limited investigations and removal actions were performed to contain and remove plating solutions and wastes that were released from the 1980s through the early 1990s. Media sampled during the RI included subsurface soil, groundwater, and seeps and piezometer water at the adjacent beach.

For subsurface soil, arsenic, cadmium, and chromium were identified as COCs and were considered major contributors to human health risk at the site. The source of inorganic chemicals detected at Area 8 is believed to be the metal plating activities associated with Building 72, except for low concentrations of detected arsenic that were suspected to be related to background concentrations. As a result, arsenic was dropped as one of the COCs at the site.

For groundwater, 10 inorganic chemicals (antimony, arsenic, cadmium, chromium [hexavalent], copper, lead, manganese, nickel, thallium, and zinc) exceeded the federal and state maximum contaminant levels (MCLs) for surface water protection, or the Model Toxics Control Act (MTCA) Method B levels (for protection of human health in groundwater). An inorganic chemical plume was found extending from the western portion of Building 72 toward Liberty Bay to the east and southeast (U.S. Navy, USEPA, and Ecology 1994). The inorganic concentrations generally decrease eastward towards Liberty Bay. Within the inorganic plume, the distribution of cadmium and chromium were well defined and could be traced to former operations of Building 72 (e.g., the chromium plume could be traced to the former chrome room in Building 72). Several other metals (copper, nickel, and zinc) detected in this area have similar distribution patterns as well.

For groundwater, 12 VOCs exceeded the federal and state MCLs (for surface water protection criteria), or MTCA Method B levels (for protection of human health in groundwater). The most frequently detected organic compounds in samples from shallow groundwater monitoring wells and seeps were TCE; 1,1,1-trichloroethane (1,1,1-TCA); 1,2-dichloroethene (1,2-DCE); and 1,1-DCE. These compounds form a plume in the upper aquifer that extends from the eastern and southern sides of Building 72 eastward and southeastward to the intertidal zone of Liberty Bay (U.S. Navy, USEPA, and Ecology 1994).

The RI results showed the areal extent of the VOC plume to be larger than the inorganic plume. Three of the four VOCs were also detected at lower concentrations in groundwater samples from an intermediate-depth well (MW8-16, screened at 45 feet below ground surface [bgs]). No VOCs were found in the deepest well (MW8-15) above the Clover Park Unit. As a result, the presence or absence of DNAPL was not conclusive during the RI. The principal source of the VOCs was believed to be solvents used in Building 72. It is also possible that some of the VOCs originated from historical use of solvents in adjacent buildings.

Petroleum hydrocarbons and aromatic compounds identified as heavy fuel oils were detected in groundwater samples from locations around Buildings 181 and 804. The source of these compounds was believed to be the former fuel storage vaults at these two buildings. The petroleum hydrocarbon contamination was remediated under the UST program, rather than CERCLA. The remediation was conducted as an independent action under MTCA regulations (Washington Administrative Code [WAC] 173-340-450) and is not discussed in detail in this 5-year review.

Because of Area 8 groundwater discharges into Liberty Bay, there is a potential for chemical migration from the groundwater to the marine environment. During the RI, some beach seep samples at Area 8 exceeded surface water quality criteria for metals. No exceedance was identified in samples taken from Liberty Bay surface water.

The baseline risk assessment did not find unacceptable human health risks for the current industrial exposure scenario. However, chemicals in soils and groundwater at Area 8 pose unacceptable risk to hypothetical future residents, although site use will remain industrial for the foreseeable future. Exposure pathways driving risk to the hypothetical future residents included ingestion of groundwater, inhalation of volatiles during household use of groundwater, and ingestion of homegrown vegetables.

No ecological risks were identified for terrestrial organisms, because of a lack of significant habitat at Area 8. Based on the RI data, the ecological risk assessment for current conditions indicated that shallow groundwater from Area 8 discharging to Liberty Bay has not caused significant risk to marine organisms. However, the risk assessment concluded that as Area 8

groundwater continues to discharge into Liberty Bay, the groundwater contaminants could lead to future risks in the marine environment if chemical concentrations increase.

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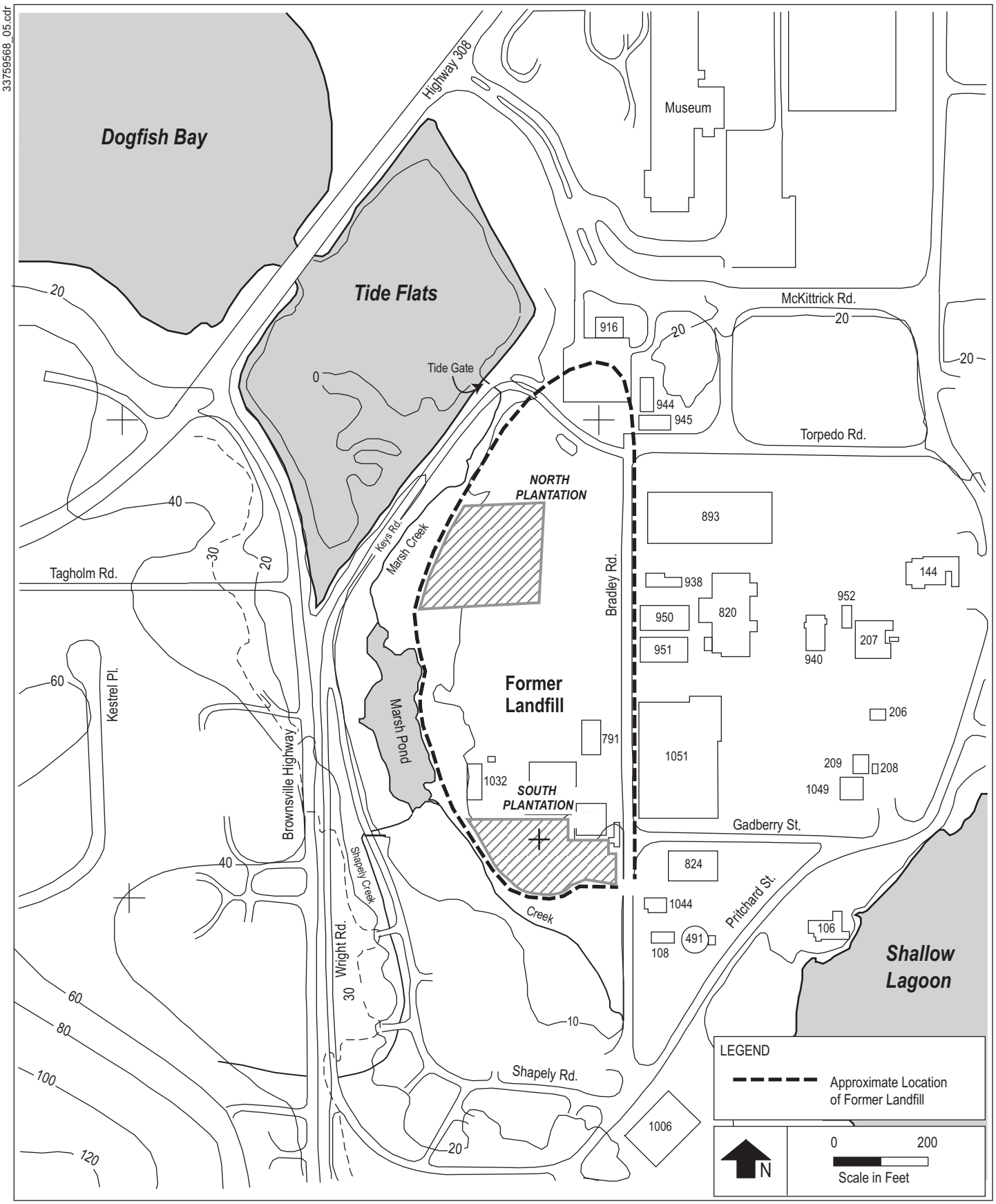
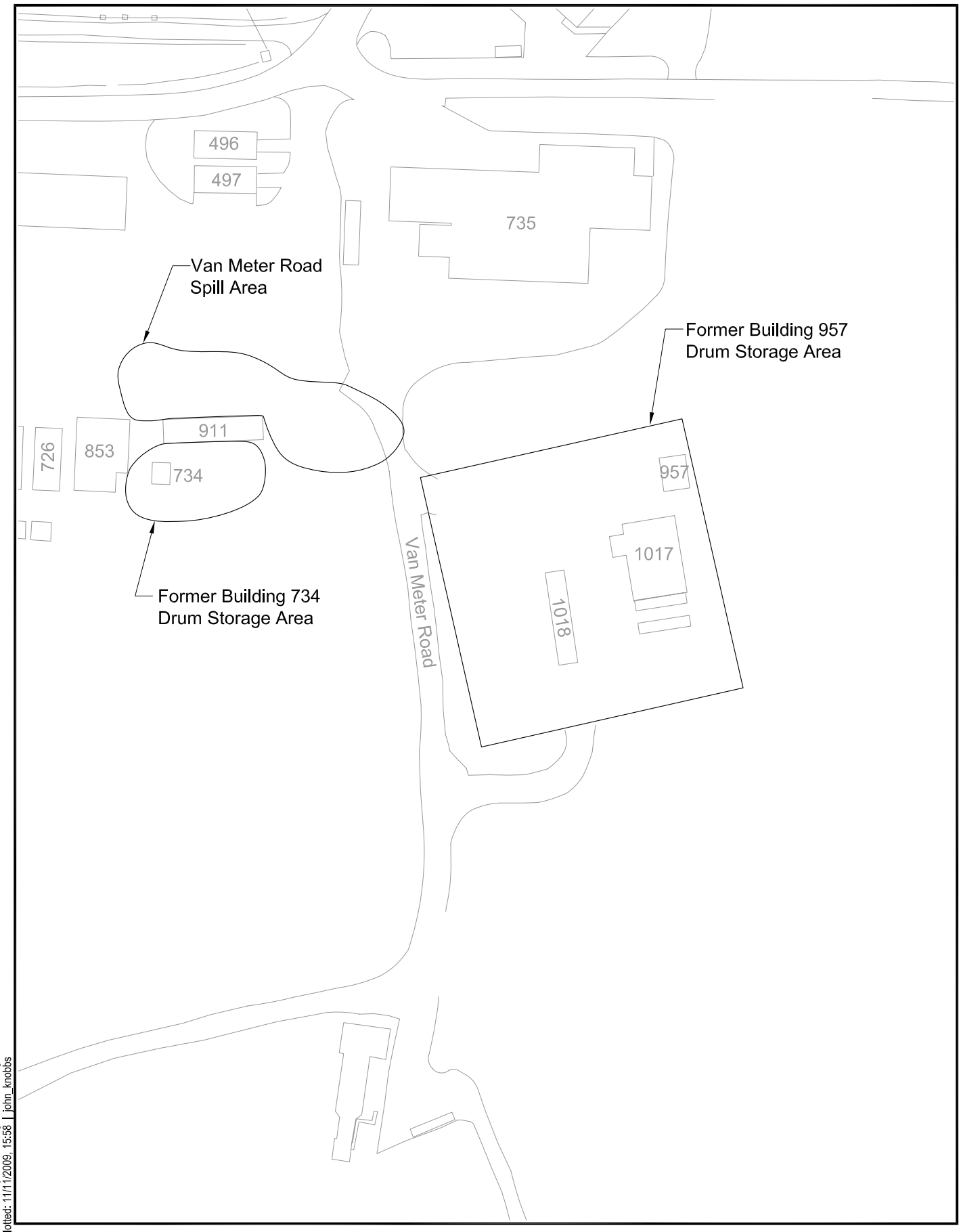


U.S. NAVY	Figure 3-1 Operable Unit 1	NBK Keyport THIRD FIVE-YEAR REVIEW



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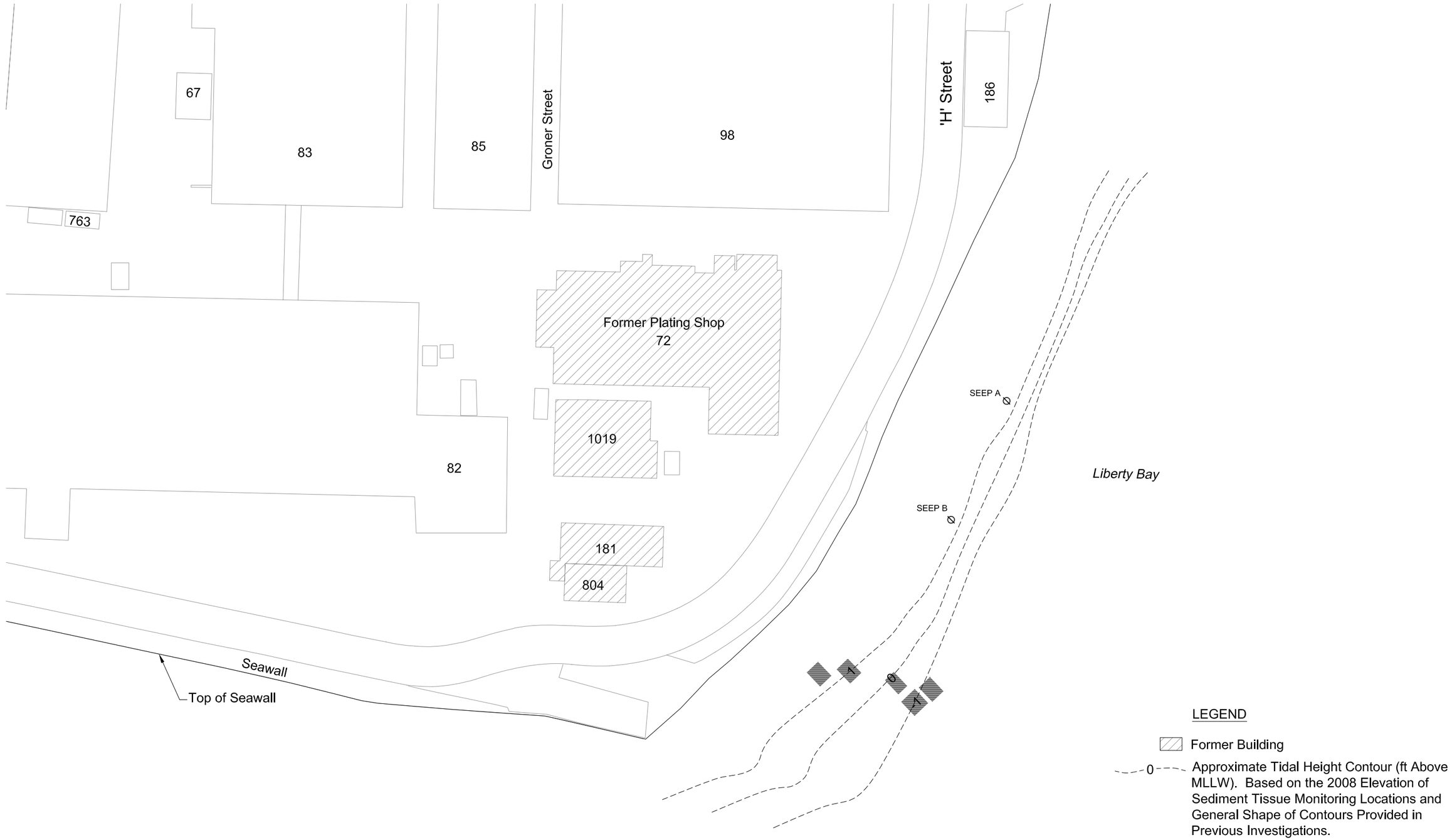
U.S. NAVY	N 0 50 100 SCALE IN FEET	**Figure 3-2** **OU 2 Area 2**	NBK Keyport THIRD FIVE-YEAR REVIEW



U.S. NAVY

NBK Keyport
THIRD FIVE-YEAR
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Figure 3-3
OU 2 Area 8

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4.0 REMEDIAL ACTIONS

The RODs for NBK Keyport required remedial actions for Area 1 at OU 1 and Areas 2 and 8 at OU 2. For each of these areas, this section provides a summary of the remedial action objectives, a description of the selected remedy, and a summary of remedy implementation, maintenance, and monitoring.

4.1 OU 1

4.1.1 OU 1 Remedial Action Objectives

The OU 1 ROD established remedial action objectives (RAOs) for each medium impacted by COCs. The RAOs are described below by medium.

RAOs for Soil, Waste, and Vapor Within the Landfill

- Prevent exposures to humans due to dermal contact with or ingestion of landfill soil or waste material that contains contaminants that may result in unacceptable risk. For this objective, unacceptable risk is defined by exposure of humans to concentrations of landfill contaminants above state cleanup levels for soil (MTCA Method B).

- Prevent exposures to humans due to inhalation of vapor from the landfill that contains contaminants that may result in unacceptable risk. For this objective, unacceptable risk is defined by exposure of humans to concentrations of landfill contaminants above state cleanup levels for air (MTCA Method B).

RAOs for Groundwater

- Prevent exposures to humans due to drinking water ingestion of groundwater that contains landfill contaminants at concentrations above state and federal drinking water standards and state cleanup levels for groundwater (MTCA Method B).

- Prevent unacceptable risks to humans and aquatic organisms due to migration of landfill contaminants via groundwater into the adjacent aquatic environments, as defined in the RAOs discussed below for surface water.

RAOs for Surface Water

- Prevent exposures to humans due to ingestion of seafood that contains contaminants at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent marine water. For this objective, unacceptable risk is defined by exposure of seafood resources to concentrations of landfill contaminants in surface water above state water quality standards, federal water quality criteria, and state cleanup levels for surface water (MTCA Method B). This refers to those surface water criteria and standards developed for the protection of human health (i.e., seafood ingestion).

- Prevent exposures to aquatic organisms due to contaminants present in surface water at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent surface water. For this objective, unacceptable risk is defined by concentrations in surface water above state water quality standards or federal water quality criteria developed for the protection of marine organisms.

RAOs for Sediments

- Prevent exposures to humans due to ingestion of seafood that contains contaminants at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the sediments of the adjacent aquatic systems and thence into seafood tissues. For this objective, unacceptable risk is defined by concentrations in littleneck clam tissues, as defined in the seafood ingestion RAO discussed below for shellfish.

- Prevent exposures to aquatic organisms due to contaminants present in sediments at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent aquatic systems. For this objective, unacceptable risk is defined by concentrations in sediments above state sediment quality standards (for chemistry) and by bioassays.

RAOs for Shellfish

- Prevent exposures to humans due to ingestion of seafood that contains contaminants at concentrations that pose unacceptable risk as a result of chemicals migrating from the landfill via groundwater into the adjacent aquatic systems. For this objective, unacceptable risk is defined by concentrations in littleneck clam tissues above a cumulative incremental cancer risk of 1×10^{-5} or above a noncancer hazard index of 1.0, using exposure assumptions for

subsistence harvesters as identified in Appendix B of the ROD. These target risk levels are within EPA's acceptable risk range, which refers to an incremental cancer risk range of 10^{-6} to 10^{-4} and a noncancer hazard index of 1.0 as acceptable targets for Superfund sites. The risk levels are also in accord with the risk assessment framework used in MTCA to establish state cleanup levels for exposures to multiple hazardous substances (WAC 173-340-708). MTCA does not establish cleanup levels that are specific for shellfish samples.

- Prevent exposures of aquatic organisms to contaminants migrating from the landfill that pose unacceptable risk. For this objective, unacceptable risk is defined by concentrations of landfill contaminants in littleneck clams above the ecological risk-based screening values (i.e., the maximum acceptable tissue concentrations, or MATCs) in Appendix J of the summary data assessment report (U.S. Navy 1997a).

4.1.2 OU 1 Remedy Selection

To achieve the RAOs, the remedial action components specified in the OU 1 ROD included the following:

- Treat VOC hot spots in the landfill by phytoremediation using poplar trees.
- Remove PCB-contaminated sediments from around the seep area, which has the highest PCB concentrations.
- Upgrade the tide gate to protect the landfill from flooding and erosion during extreme tide events.
- Upgrade and maintain the landfill cover.
- Conduct long-term monitoring (LTM), including phytoremediation monitoring, intrinsic bioremediation monitoring, and risk and compliance monitoring.
- Take contingent actions for off-base domestic wells, if necessary.
- Implement institutional controls.

4.1.3 OU 1 Remedy Implementation

Phytoremediation

The phytoremediation remedy component was implemented in accordance with the ROD in spring 1999 with the planting of two plantations of hybrid poplar trees. Each plantation was located above a hot spot of VOC contamination in groundwater. The goal of phytoremediation is to utilize the soil moisture and groundwater uptake capability of the hybrid poplar trees to remove and treat VOC-contaminated groundwater, thus reducing the long-term potential for VOC migration from the site.

Design criteria specified in the ROD (U.S. Navy, USEPA, and Ecology 1998) for implementation of phytoremediation at OU 1 included selecting a planting density with consideration of water uptake by poplar trees to accomplish the following:

- Avoid adverse dewatering of the wetlands adjacent to the landfill.
- Avoid adverse changes in groundwater flow (such as drawing saline water from the marsh pond to the tree stands).
- Maximize contaminant removal by the trees.

The first two design criteria were met by the groundwater modeling performed by the U.S. Geological Survey (USGS), which showed that the trees would not adversely affect the wetlands, or cause adverse changes in groundwater flow (U.S. Navy 1999a, Appendix B). The third design criterion was met by selecting an initial planting density that maximized water usage by the young trees and then thinning the trees as they grew to create a closed canopy of healthy, properly spaced trees.

Process monitoring and control criteria specified in the ROD included the following:

- *Air quality*: assessment of whether the mature stands of trees comply with action-specific regulatory requirements for air quality (i.e., acceptable source impact levels [ASILs] of the Puget Sound Clean Air Agency [PSCAA])
- *Leaf management*: assessment of whether the leaves retain toxic substances that require special leaf management (i.e., can the leaves be allowed to fall and degrade naturally, or do they pose unacceptable risks to human health and the environment and thus need to be collected for proper disposal?)

- *Limb management*: assessment of whether the tree limbs resulting from process operation and maintenance (O&M) (e.g., pruning and thinning) retain toxic substances that require special management to comply with action-specific ARARs (e.g., land disposal regulation) or pose no unacceptable risk to human health and the environment

The process monitoring and control criteria were met by the demonstration sampling results reported in the October–December 2001 status report (U.S. Navy 2002a). Transpired air was found to contain TCE and tetrachloroethene (PCE) concentrations below the applicable ASILs and therefore, to not represent a threat to human health and the environment. The results of tree tissue sampling indicated that all types of tree tissue were safe for disposal without restrictions, including burning in residential fireplaces.

Performance monitoring criteria are specified in the ROD as follows:

- Water-level measurements and contour mapping of the water table surface
- Sampling for VOCs and natural attenuation parameters in groundwater at selected locations

Tree planting began in April 1999, and by June 1999, planting and construction activities (e.g., irrigation system implementation, fencing, and fertilization) of the two plantations were completed (U.S. Navy 1999b). The two plantations, named the "north" and "south" plantations are each slightly less than 1 acre in size. Construction work for the two plantations included the following:

- Establishing the plantation boundary locations, based on the figures in the ROD
- Asphalt and fencing removal
- Storm drain relocation
- Curb and fence construction
- Landfill surface preparation and debris removal
- Placement of planting soil and soil amendments
- Installation of 3 wells (MW1-41 and 2 irrigation wells), 10 piezometers, and 2 lysimeters

- Installation of irrigation systems at both plantations
- Planting the hybrid poplar trees

Landfill debris and soil removed during plantation construction were sampled, characterized, and recycled or disposed of at appropriate facilities.

The tree planting process included loosening the soil with a single-tined plow and then pressing dormant hardwood cuttings of the hybrid poplars into the plowed furrow. Trees were planted in north-south rows spaced approximately 10 feet apart, with individual trees spaced 6 feet apart within rows. A total of 545 trees were planted at the north plantation, and 360 trees were planted at the south plantation. A summary of the construction activities, specifications for on-site equipment, and as-built drawings are included in the phytoremediation closure report (U.S. Navy 1999b). Figure 3-1 shows the locations of the two plantations.

The work plan for phytoremediation implementation established that the effectiveness of phytoremediation was to be evaluated on the basis of a "weight of evidence," rather than specific numerical criteria. Performance evaluation criteria, actions to be taken on the basis of performance evaluations, and the timing of performance evaluations were selected on the basis of the experience of the phytoremediation expert retained by the Navy, as applied to the site conditions.

Performance criteria included the following:

- *Tree health:* Healthy trees indicate water uptake by the trees. When the trees take up water containing TCE-family compounds, those compounds are metabolized. Tree health will be assessed according to standard forestry practices.
- *Groundwater flow:* Changes to the groundwater flow pattern that reduce contaminant migration are expected as the result of groundwater withdrawal either directly by the trees or through the irrigation wells. Changes in the groundwater flow pattern will be demonstrated by contour maps produced as part of periodic status reports. The contour maps will be based on depth-to-groundwater data from monitoring wells and piezometers.
- *Contaminant concentrations:* A downward trend in concentrations of TCE-family compounds in groundwater and surface water samples collected from the immediate vicinity of the plantations will be considered evidence of phytoremediation effectiveness.

Phytoremediation is to be considered effective if the conditions in item 1 and either item 2 or 3 in the following list are met.

1. Two healthy stands of trees are present at the selected locations at OU 1 after the second growing season and subsequent growing seasons.

2. The groundwater gradient in the area of the two plantations is reduced for at least 4 months out of every year, as evaluated at the end of the second growing season and subsequent growing seasons.

3. The downward trend in concentrations of TCE-family compounds in groundwater and surface water described previously is notable in the overall data set at the end of the fifth growing season.

Regarding the potential ineffectiveness of phytoremediation, the OU 1 ROD (U.S. Navy, USEPA, and Ecology 1998) states the following: "If phytoremediation is determined to be ineffective and is discontinued, natural attenuation and intrinsic biodegradation will be evaluated to determine whether they satisfy the key objectives for which the phytoremediation action was intended to address."

Sediment Removal

PCB-contaminated sediment removal was completed in 1999 (U.S. Navy 1999c). The objective of the sediment removal was to decrease the amount of PCBs found in the marsh sediments, thereby reducing current ecological risks to the marsh and reducing the potential for PCBs to migrate and cause unacceptable risks elsewhere in the future. Although the PCB concentrations were below levels requiring active cleanup, this remedial action was selected to reduce the potential for PCBs to move into the tide flats and Dogfish Bay and to accumulate in harmful quantities in the future.

The goal of the sediment removal component of the remedy was to remove approximately the top 6 inches of surface sediments from the area of the marsh downgradient of the landfill seep (Figure 3-1), where previous sampling had shown the highest PCB concentrations. To minimize disruptions and short-term impacts on the marsh (as required by the ROD), a high-pressure vacuum truck was used with a suction line for vacuuming the sediment directly from the marsh into sludge boxes (heavily reinforced roll-off boxes suitable for transporting material having high moisture content). Prior to sediment removal, grade stakes were set on a 10-foot grid throughout the marsh to establish control over the depth of removal. A small tiller was used as needed to loosen the sediment and organic matter before vacuuming. Overall, approximately 75 tons of sediment was removed from the site and transported to a Subtitle D landfill for solidification and disposal.

No additional sampling was conducted during the sediment removal action. Instead marsh sediment sampling was incorporated into the LTM program.

Tide Gate Upgrade

The tide gate upgrade was completed and fully operational by November 1999 (U.S. Navy 1999c). The intent of upgrading the existing tide gate was to improve the control of tidal flow between the tide flats and the marsh, thereby ensuring that the landfill is protected from extreme tidal action that could flood its surface, erode its banks, or adversely affect the groundwater level within the landfill mass. The existing flap gate was replaced with a Waterman/Nekton self-regulating tide gate. In order to provide adequate support to the new tide gate system, a reinforced concrete collar was constructed at the downstream end of the existing culvert adjacent to the tide flats, and a new 36-inch reinforced concrete culvert was installed to replace the existing corrugated metal pipe, which was in poor condition. During culvert installation, soil that was unsuitable as bedding material and embankment material for the new culvert was excavated and disposed of along with the excavated sediment. Crushed, recycled concrete was laid down as bedding material for the pipe and the culvert. A similar concrete collar was installed at the upstream end of the culvert and equipped with a security grate to prevent unauthorized entry to the facility via the culvert.

Upgrade Landfill Cover

The requirements for the landfill cover upgrade remedy component were described in the OU 1 ROD (U.S. Navy, USEPA, and Ecology 1998) as follows:

> This element of the selected remedy involves upgrading the landfill cover and maintaining it in good condition. The existing asphalt will be removed from those parts of the landfill where the poplar trees are to be planted. The landfill surface in these planted areas will be maintained as described in Section 11.1 (of the OU 1 ROD). The remainder of the existing asphalted areas will be upgraded to repair cracks and other damaged pavement. Portions of the landfill not presently covered with asphalt will be left unpaved.

To implement this component of the remedy, the Navy first assessed the existing conditions of the asphalt on the paved portions of the landfill and considered approaches for repair or repaving (U.S. Navy 2002b). Based on this assessment in 2002, the Navy concluded that the existing paving between the two phytoremediation plantations should be removed and replaced with new asphalt. It was also concluded that the repaving project should minimize regrading of the landfill surface, should minimize import and export of subgrade material, and should provide upgraded stormwater flow control and water quality treatment.

The Navy finalized a design for the repaving effort in August 2002 (U.S. Navy 2002c) and contracted for construction in fall 2002. Construction was performed in two phases because of weather delays over the winters of 2002 to 2003 and because shallow landfill debris was found to be more pervasive than expected beneath the area to be repaved. Phase I construction activities were conducted between November 4 and December 12, 2002. Phase II construction activities were conducted between July 21 and December 4, 2003. The construction work was accepted by the Navy in January 2005.

Major components of the repaving included the following:

- Construction of upgraded stormwater facilities, including catch basins, piping, oil-water separators, and bioswales on the east and west sides of the paved area
- Removal, pulverization, and reuse of existing asphalt
- Regrading of the subgrade material to achieve drainage to the upgraded stormwater facilities
- Placement of geotextile grid and imported base course material
- Paving the site with new asphaltic concrete and adding striping and curbing for parking use
- Planting the bioswales

Soil and landfill debris that could not be reincorporated into the landfill was sampled, characterized for disposal, and disposed of off site at the Olympic View Sanitary Landfill in Port Orchard, Washington. Groundwater pumped from open excavations was temporarily stored on site during construction, sampled, characterized for disposal, and disposed of off site at Philip Service Facility in Kent, Washington (U.S. Navy 2004a).

Long-Term Monitoring

The LTM program at OU 1 began in 1999 with sampling of two deep water supply wells and groundwater at and adjacent to the two phytoremediation plantations. During the first 4 years following phytoremediation implementation, the OU 1 LTM program consisted of three parallel programs performed by the Navy and the USGS. The Navy performed phytoremediation monitoring and risk and compliance monitoring, while the USGS performed intrinsic bioremediation monitoring. Beginning in 2003, risk and compliance monitoring and phytoremediation monitoring were consolidated as a single program. The USGS continued to perform intrinsic bioremediation monitoring.

Additional discussion of the operation, maintenance, and monitoring conducted at OU 1 since the first 5-year review is included in Section 4.1.4.

Contingent Remedial Actions

This component of the selected remedy required the Navy to prepare for implementing additional remedial actions to "prevent drinking water risks if the long-term monitoring results show that off-base domestic wells could become contaminated in the future" (U.S. Navy, USEPA, and Ecology 1998). To satisfy this component of the selected remedy, the Navy prepared a contingent remedial action plan (CRA plan), which was finalized in March 2003 (U.S. Navy 2003a).

The CRA plan specifies the conditions under which the Navy will implement additional remedial actions related to OU 1 and describes the actions to be implemented. The basis for additional remedial actions is defined by the CRA plan as the identification of significant contaminant concentrations migrating from OU 1 to water supply wells in the area. Contaminant migration is to be identified by comparing groundwater sampling data from certain wells (called "sentinel wells") to a decision matrix. The plan describes the source of the groundwater sampling data and the decision matrix.

The plan also describes the remedial actions to be implemented, which may include the following:

- Additional sampling of the sentinel well
- Sampling of potentially affected water supply wells
- Providing bottled water to homeowners
- Installing of filtration systems at specific water supply wells
- Replacing affected water supply wells with either a connection to the county water supply, or a new and deeper water supply well

Institutional Controls

An institutional controls management plan was prepared and finalized on May 19, 2000, to address the requirements outlined in both the OU 1 and OU 2 RODs (U.S. Navy 2000a). The plan was updated to include Site 23 in 2009 (U.S. Navy 2009a). The intent of the institutional controls at OU 1 is to prevent undue exposure to landfill contaminants in the future. The institutional controls management plan outlines administrative procedures and actions that will limit or prevent activities that could interfere with the remedial activities at the site. These

controls will preclude installation of water wells at OU 1 (except environmental [monitoring or remedial action] resource wells) and prevent development or activity that would disturb the landfill, tide flat, or adjoining marsh and shoreline in a manner that could lead to unacceptable risks to human health.

In addition to the institutional controls management plan, NBK is in the process of drafting a Regional Land Use Control Instruction covering the Bremerton naval complex, Jackson Park Family Housing, Naval Hospital Bremerton, NBK Bangor, NBK Keyport, and Naval Magazine Indian Island. This instruction will be completed by December 31, 2011.

4.1.4 OU 1 Operation, Maintenance, and Monitoring

Since the second 5-year review in 2005 (U.S. Navy 2005a), the Navy has continued operation, maintenance, and monitoring of the OU 1 remedy. As discussed in Section 4.1.3, monitoring at OU 1 was initially conducted under three parallel programs:

- Phytoremediation operation, maintenance, and monitoring
- Risk and compliance monitoring
- Intrinsic bioremediation monitoring

Beginning in 2003, risk and compliance monitoring and phytoremediation monitoring were consolidated as a single program. The USGS continued to perform intrinsic bioremediation monitoring as a separate program. In addition to these three programs, the Navy also performs:

- Tide gate inspection and maintenance
- CRA monitoring

The CRA monitoring program was implemented in conjunction with the risk and compliance monitoring program and the phytoremediation monitoring program. Tide gate inspection and maintenance has been performed since the tide gate was upgraded in 1999 and has occurred four times since the last 5-year review.

Institutional controls inspections have been carried out concurrently with these monitoring, operation, inspection, and maintenance activities.

Phytoremediation Operation, Maintenance, and Monitoring

Phytoremediation operation, maintenance, and monitoring activities that were begun immediately after planting were continued over the last 5-year review period. The primary objective of the initial monitoring and nurturing phase was to establish mature, healthy stands of trees. A closed canopy of healthy trees covering the two hot spots at the plantations is expected to maximize contaminant uptake by the trees. The objective of later monitoring was to ensure

that tree health had been maintained and to assess the effectiveness of the phytoremediation component of the remedy.

The original work plan anticipated that 2 years of initial monitoring and nurturing would be required to establish stands of trees that would begin taking up contaminants (U.S. Navy 1999a). Monitoring during this time would be used to establish background concentrations of contaminants in sampled media, document initial contaminant uptake by the trees, document the effects of the trees on the shallow aquifer, and satisfy the "demonstration" sampling requirements of the ROD (U.S. Navy, USEPA, and Ecology 1998). Demonstration sampling was specified in the ROD to show that tree products such as transpired air, stems, and leaves did not remain contaminated after the uptake and metabolization of contaminants by the trees. The demonstration sampling defined in the original work plan also addressed issues such as (1) possible increased leaching of contaminants from soil to groundwater as a result of removing the asphalt cap on the landfill to plant trees and (2) effects from irrigating the plantations during the summer.

At the end of the second growing season (through November 2000), it was apparent that the trees had not grown as quickly as anticipated and were not yet taking up contaminated groundwater. Because of this, the original work plan was amended to include a third year of monitoring and nurturing (U.S. Navy 2001a). Some of the demonstration sampling planned for the second growing season was rescheduled for the third growing season on the basis of the growth rates at the plantations.

At the end of the third growing season (November 2001), the Navy decided to extend the existing sampling schedule for a fourth growing season (through 2002). The results of the fourth growing season were intended to help assess the effectiveness of phytoremediation and test procedures to be used for long-term O&M. All of the demonstration sampling requirements of the ROD were met by the end of the third growing season, and, therefore, no demonstration sampling was carried forward into later work plans.

Operation, maintenance, and monitoring activities since the last 5-year review have included the following:

- Periodic groundwater elevation measurements in upper aquifer monitoring wells and piezometers in and around the plantations
- Periodic groundwater and surface water sampling and analysis from wells and surface water stations in and around the plantations
- Plantation inspections and maintenance necessary to maintain healthy trees

All Area 1 phytoremediation monitoring activities since the last 5-year review were performed in accordance with the LTM work plan. The work plan was revised in 2004, 2006, and 2007 (U.S. Navy 2004a, 2006a, and 2007a). However, the Area 1 phytoremediation monitoring program remained largely unchanged during this period. Sampling groundwater wells for 1,4-dioxane was added as a one-time sampling event in the 2006 work plan, with actual sampling occurring in 2006. In the 2007 work plan, the monitoring frequency for seep SP1-1 was reduced from twice annually to once. Phytoremediation monitoring at all other locations was performed twice annually. No other changes were made to the phytoremediation monitoring program since the last 5-year review.

Periodic groundwater elevation measurements in monitoring wells and piezometers in and around the plantations occurred quarterly since the last 5-year review. (Note that groundwater elevation measurements were conducted monthly through April 2003, prior to the start of this 5-year review period.) The ROD-specified frequency for monitoring groundwater elevations is four times per year for the first 5 years, once per year from 5 to 10 years, and once every 5 years after 10 years. Since it has been 10 years since remedy implementation in 1999, the current monitoring frequency exceeds the requirements specified in the ROD. These groundwater elevation measurements have been used to assess changes to the groundwater flow pattern in the shallow aquifer attributable to the phytoremediation plantations. Monitoring well locations where groundwater elevation was measured are shown on Figure 4-1.

Semiannual groundwater sampling and analysis for VOCs in eight monitoring wells (1MW-1, MW1-2, MW1-3, MW1-4, MW1-5, MW1-16, MW1-20, and MW1-41), and one surface water location (MA-12) was conducted since the last 5-year review. (Note that groundwater and surface water sampling was conducted quarterly through 2003, prior to the start of this 5-year review period.) Semiannual sampling of one seep (SP1-1) occurred through 2006 and was then reduced to annually for the remainder of the 5-year review period. The ROD-specified frequency for monitoring groundwater and surface water is once per year for the first 5 years, once every 2 years between 5 and 10 years, and once every 5 years after 10 years. The current monitoring frequency exceeds the requirements specified in the ROD. The sampling locations and frequency of sampling are summarized in Table 4-1. Sampling locations are shown on Figure 4-1.

Plantation inspections have occurred eight times per year since the last 5-year review. Additional maintenance activities have occurred periodically as necessary to maintain healthy stands of trees.

Risk and Compliance Monitoring

Long-term monitoring for assessing risk and compliance was described in the ROD as consisting of groundwater level measurements and groundwater, seep, marine sediment, and tissue sampling. The overall objective of the LTM program is to monitor trends in chemical

concentrations and evaluate whether the selected remedy meets the RAOs and remains protective of human health and the environment (U.S. Navy 2009c). LTM data are also used to monitor the need for CRAs under the CRA plan (U.S. Navy 2003a).

Activities under the LTM program since the last 5-year review have consisted of the following:

- Periodic groundwater elevation measurements in upper and intermediation aquifer monitoring wells and piezometers in and around the plantations
- Groundwater sampling and analysis of seven monitoring wells screened within the upper aquifer, five monitoring wells screened within the intermediate aquifer, and two water supply wells screened in the deep aquifer
- Sampling and analysis of five surface water locations and one seep
- Sampling and analysis of nine sediment and six shellfish tissue locations

The sampling locations and frequency of sampling for each of these media are summarized in Table 4-1. Sampling locations are shown on Figure 4-2. The sampling program is described by medium in the subsections below. The most recent monitoring results are discussed in Section 6.4.

All Area 1 risk and compliance monitoring activities and CRA monitoring activities since the last 5-year review were performed in accordance with the LTM work plan. The work plan was revised in 2004, 2006, and 2007 (U.S. Navy 2004a, 2006a, and 2007a). However, the Area 1 risk and compliance monitoring program remained largely unchanged during this period. Sampling groundwater wells for 1,4-dioxane was added as a one-time sampling event in the 2006 work plan, with sampling also occurring in 2006. Otherwise, no other changes were made to the risk and compliance monitoring program since the last 5-year review. The Area 1 CRA monitoring program remained unchanged during this 5-year review period. Sampling results for CRA monitoring wells indicated a continued sampling frequency of once every 2 years.

Groundwater Monitoring. Groundwater sampling is conducted to monitor the extent and concentrations of VOC contamination in the upper, intermediate, and deep aquifers beneath and downgradient of the former landfill. The analytical results are compared to the groundwater RGs established in the ROD (based on drinking water and seafood ingestion pathways), and the long-term groundwater contamination trends are tracked to evaluate if the RGs have been met.

Annual groundwater sampling and analysis for VOCs in seven monitoring wells screened in the upper aquifer (1MW-1, MW1-2, MW1-4, MW1-5, MW1-16, MW1-17, and MW1-41), five monitoring wells screened in the intermediate aquifer (MW1-9, MW1-25, MW1-28, MW1-38,

and MW1-39), and two public water wells screened in the deep aquifer (Kitsap County Public Utility District [PUD] and Navy #5) was conducted since the last 5-year review. The ROD-specified frequency for monitoring groundwater in the two deep public water wells is once per year. The ROD-specified frequency for monitoring groundwater in all other wells is once every two years for the first 5 years, and then once every 5 years thereafter. Therefore, the current monitoring frequency either meets or exceeds the requirements specified in the ROD. Monitoring well locations where groundwater was sampled are shown on Figure 4-2.

In addition to groundwater sampling, water-level measurements are collected throughout OU 1 once every 2 years. These data are used to estimate groundwater gradient and flow directions beneath and downgradient of the former landfill in both the upper and intermediate aquifers. The ROD-specified frequency for monitoring groundwater elevations is once every 2 years for the first 5 years and once every 5 years after 5 years. Therefore, the current monitoring frequency exceeds the requirements specified in the ROD. Monitoring well locations where groundwater elevation was measured are shown on Figure 4-2.

Surface Water and Seep Monitoring. Surface water, including one seep, is sampled periodically, as specified in the ROD, for monitoring of fate, transport, and natural attenuation of VOCs in surface water. These stations are located in a series aligned upstream to downstream, beginning in the marsh pond adjacent to the landfill, through the outlet channel to the tide flats, and out to Dogfish Bay. The results of the surface water sampling are compared to the surface water RGs, which are based on risks via the seafood ingestion and ecological risk pathways.

Annual sampling of five surface water locations (DB-14, MA-09, MA-11, MA-12, and TF-19) and analysis for VOCs were conducted since the last 5-year review. In addition, the seep (SP1-1) was sampled once every two years for PCBs and pesticides. The ROD-specified frequency for sampling surface water including the seep is once every 2 years for the first 5 years and once every 5 years thereafter. Therefore, the current monitoring frequency exceeds the requirements specified in the ROD. Surface water and seep monitoring locations are shown on Figure 4-2.

Sediment Monitoring. The OU 1 ROD selected sediment locations distributed throughout the marsh, tide flats, and Dogfish Bay for monitoring of fate and transport of contaminants migrating from the landfill through the marsh pond. New location MA-14 was established prior to the first LTM event and added to the sampling program. This location is located at the downgradient end of the sediment removal area and is used to monitor chemical concentrations along the outlet of the marsh. The results of the sediment sampling were compared to the established RGs.

Nine sediment locations (DB-05, DB-07, DB-08, MA-09, MA-11, MA-14, TF-18, TF-20, and TF-21) were sampled for PCBs, pesticides, semivolatile organic compounds (SVOCs), and metals in 2009. Sediment samples had previously been collected in 1996 (prior to the signing of the OU 1 ROD), 2000, 2002, and 2004. A total of 10 sediment stations have been sampled

historically, but not every station was sampled during every sampling event. In 1996, new station MA-14 did not exist and so was not sampled. In 2000, the eight locations designated in the ROD were sampled, in addition to new location MA-14. In 2002, only 2 of the 10 stations were sampled (MA-09 and MA-14), in accordance with the LTM plan (U.S. Navy 2002d). In 2004, the same nine stations were sampled as were sampled in 2000. The ROD-specified frequency for sampling sediment is once every 5 years. Therefore, the current monitoring frequency meets the requirements specified in the ROD. Sediment monitoring locations are shown on Figure 4-2.

Shellfish Tissue Monitoring. Shellfish tissue is sampled periodically for monitoring human health ingestion risks in the tide flats and Dogfish Bay, where shellfish harvesting could potentially occur. Six shellfish sampling locations (DB-05, DB-07, DB-08, TF-18, TF-20, and TF-21) were sampled for PCBs, pesticides, SVOCs, and metals in 2009. Shellfish tissue samples had previously been collected in 1996 (prior to the signing of the OU 1 ROD), 2000, and 2004. VOCs were added to the analytical suite for the samples collected in 2000. Because target VOCs were not detected in tissue samples, it was concluded that the RGs had been reached for these COCs in shellfish tissue (U.S. Navy 2002e). Based on this finding, VOCs were dropped from the analyte list during subsequent monitoring events. The ROD-specified frequency for sampling shellfish tissue is once every 5 years. Therefore, the current monitoring frequency meets the requirements specified in the ROD. Shellfish tissue monitoring locations are shown on Figure 4-2.

Intrinsic Bioremediation Monitoring

As described in the summary data assessment report (U.S. Navy 1997a) and the ROD for OU 1 (U.S. Navy, USEPA, and Ecology 1998), groundwater oxidation reduction (redox) conditions at the site appear to be generally favorable for complete degradation of chlorinated VOCs into their harmless byproducts—carbon dioxide, water, and chloride. The favorable conditions identified are strongly reducing groundwater beneath the source area (which is favorable for reductive dechlorination of TCE and some DCE), followed by mildly reducing groundwater downgradient of the source area (which is favorable for direct oxidation of DCE and vinyl chloride). Because phytoremediation activities could potentially affect redox conditions at the site, the ROD specified that performance monitoring should include the redox conditions beneath the plantations to check for potential adverse effects from phytoremediation. The ROD also allowed for an evaluation of natural attenuation processes in the event that the phytoremediation component of the remedy was discontinued.

The Navy began a cooperative effort with the USGS in 1995 to investigate various natural attenuation mechanisms at OU 1 (USGS 2003). The investigations performed under this cooperative effort have been used to meet the OU 1 ROD goals related to natural attenuation evaluation. Field and laboratory studies conducted from 1996 through 2000 showed that natural

attenuation and biodegradation of VOCs in shallow groundwater at OU 1 are substantial (U.S. Navy 1997a, Bradley et al. 1998, and USGS 2002). Since the second 5-year review in 2004, the USGS has continued to monitor the geochemistry of OU 1 groundwater to verify that conditions remain favorable for VOC biodegradation. Sampling and analysis for VOCs and biodegradation indicator parameters have been conducted annually since 2004 in June of each year. The USGS also measured groundwater elevations during each sampling event.

The USGS measured groundwater elevations and sampled groundwater for geochemical constituents (redox parameters) and ethane and ethene in 13 or 14 monitoring wells (1MW-1, MW1-2, MW1-3, MW1-4, MW1-5, MW16, MW1-17, MW1-20, MW1-25, MW1-28, MW1-33, MW1-38, MW1-39, and MW1-41) and 9 piezometers (P1-1, P1-3, P1-4, P1-5, P1-6, P1-7, P1-8, P1-9, P1-10) annually since the last 5-year review. VOCs were measured annually in seven piezometers (P1-3, P1-4, P1-6, P1-7, P1-8, P1-9, and P1-10), and less frequently in four wells (MW1-25, MW1-28, MW1-38, MW1-39) and two piezometers (P1-1 and P1-5). Although USGS did not analyze for VOCs in samples collected from wells 1MW-1, MW1-2, MW1-4, MW1-5, and MW1-16, these wells were sampled semiannually under the phytoremediation monitoring program. VOCs, ethane, and ethene were measured once in 2005 at 10 passive diffusion sampling locations (S1, S2, S2B, S3, S3B, S4, S4B, S5, S5B, and S6) and two surface water grab sampling locations (MA12 and SW-S6). All sampling locations are shown on Figure 4-2.

The ROD specifies monitoring of the northern plantation wells (1MW-1 and MW1-2) and the southern plantation wells (MW1-4, MW1-5, and MW1-16) for VOCs and redox parameters once every year for the first 5 years, and once every 5 years thereafter. For the intermediate aquifer wells, MW1-25, MW1-28, and MW1-39, the ROD-specified monitoring for VOCs and redox parameters is once every 2 years for years 1 through 5 and once every 5 years thereafter. The ROD does not specify any monitoring in piezometers, passive diffusion sampling locations, or surface water locations. As a result, the current intrinsic bioremediation monitoring program exceeds the requirements in the ROD with regard to number of locations and frequency of monitoring.

Institutional Controls Inspections

Annual inspections of the institutional controls have been conducted since 2002. Annual inspections have included completion of the inspection checklist included in the institutional controls management plan and preparation of a brief narrative report, both of which are submitted to Ecology and EPA. Inspected institutional controls match the requirements of the OU 1 and OU 2 RODs. Each narrative report summarizes and evaluates the findings of the inspection for each area and OU, discusses any corrective actions needed, and then presents conclusions regarding the ongoing effectiveness of the institutional controls.

4.2 OU 2

4.2.1 OU 2 Remedial Action Objectives

RAOs were developed for Areas 2 and 8 in the OU 2 ROD and were stated in a narrative format. Descriptions of the RAOs have been paraphrased in the sections below by area.

RAOs for Area 2

The RAOs for OU 2 Area 2 are the following:

- Prevent human health exposures to TCE and vinyl chloride in soil and groundwater by pathways such as ingestion of groundwater, inhalation of volatiles while showering, or ingestion of soil or vegetables grown in the soil.
- Restore the groundwater to drinking water quality for VOCs such as TCE and vinyl chloride.

RAOs for Area 8

The RAOs for OU 2 Area 8 are the following:

- Prevent human ingestion of groundwater containing metals and VOCs at concentrations above drinking water standards or acceptable human health risk levels.
- Protect sediments and surface water quality offshore of Area 8 in Liberty Bay from contaminants in groundwater that could cause future adverse impacts or human health risks.
- Prevent humans from coming into direct contact with, or ingesting, soil containing COCs at concentrations that would present an unacceptable risk to human health.
- Protect groundwater and surface water quality from soil containing COCs.

4.2.2 OU 2 Remedy Selection

The remedial action components specified in the OU 2 ROD to meet the RAOs for each area are described by area in the sections that follow.

Area 2 Remedy Selection

The selected remedy for Area 2 consists of institutional controls and groundwater monitoring. The purpose of the institutional controls was to prohibit residential use of the site and to prevent construction of domestic wells. The monitoring was to be used to establish COC trends in groundwater and to determine when institutional controls could be discontinued. As part of the monitoring program, the Navy agreed to install additional upgradient wells to confirm that no upgradient source of COCs exists.

Area 8 Remedy Selection

The selected remedy for Area 8 includes the following components:

- Removal and off-site disposal of vadose-zone soil from COC hot spots
- Groundwater monitoring in the water table aquifer
- Sediment and tissue monitoring to assess the potential long-term impacts of contaminated groundwater discharge to Liberty Bay
- Contingent groundwater control actions based on risk assessment of sediment and tissue monitoring data
- Institutional controls

Following signing of the OU 2 ROD, an ESD was developed to clarify that the soil remedial action at Area 8 would be based on total chromium content in the soil, conservatively assuming all of the chromium was in the most toxic +6 valence form (based on previous groundwater sampling results on chromium speciation) (U.S. Navy, USEPA, and Ecology 1996). The ESD explained that this approach would be taken to minimize the risks of error and to be conservative. The ESD also revised the work schedule to allow for testing and removal of soils based on total chromium content after a new plating area was constructed.

The remedy selected for Area 8 was not expected to meet groundwater RGs based on drinking water criteria, nor the goals for the protection of adjacent surface water throughout the site. Virtually all of the fill area would have to be excavated to meet these goals, and the cost of doing this was deemed disproportionate to the benefit. A risk management decision was made that the groundwater compliance criteria would be measured at the nearshore wells as conditional points of compliance. Additional protectiveness was to be achieved by implementing institutional control measures at the site (U.S. Navy 2000b).

4.2.3 OU 2 Remedy Implementation

The implementation of the remedy components for Areas 2 and 8 of OU 2 are described by area in the sections that follow.

Area 2 Remedy Implementation

The investigation component of the selected remedy was satisfied by the installation and sampling of three new wells (2MW-4, 2MW-5, and 2MW-6). Ongoing monitoring of these wells and other wells at Area 2 satisfies the monitoring component of the remedy. Monitoring at Area 2 is discussed further in Section 4.2.4. The institutional controls plan discussed in Section 4.1.3 covers Area 2 and satisfies the institutional controls component of the remedy. Institutional controls for Area 2 are used to prevent residential land use and prevent construction of domestic wells.

Area 8 Remedy Implementation

Soil Removal. Building 72, the former plating shop, was demolished in 1999 after industrial operations were transferred to the new plating shop at the facility. Building 72 demolition was accompanied by soil removal at hot spots delineated during the RI/FS and specified in the OU 2 ROD. The soil hot spot removal remedy involved excavating soil contaminated with cadmium and chromium to 9 feet bgs. Hot spot areas were defined as areas with cadmium and chromium concentrations exceeding state MTCA Method B cleanup levels for soil ingestion, which are 80 mg/kg for cadmium and 400 mg/kg for chromium.

Extensive sampling programs were implemented for the Building 72 demolition and hot spot removal to delineate and characterize the nature of soil contamination at Area 8 for proper soil removal and disposal. A preliminary sampling and analysis program was conducted in 1996, which included perimeter soil sampling and soil sampling under the building. Sampling results indicated the presence of soil contaminated with total petroleum hydrocarbons (TPH), but no soil contamination from plating operations beyond the perimeter of Area 8.

A delineation sampling program was conducted as part of the Building 72 demolition and hot spot removal. The program was implemented in three phases from April 1998 through January 1999, with subsurface soil sampling by soil borings located on a grid setting across the site. Samples were collected from selected intervals based on the requirements of the remedial action work plan (U.S. Navy 1997b) and were analyzed for total metals, VOCs, SVOCs, and TPH-diesel. Overall, a total of 107 soil borings were drilled, and 78 of the 107 borings were used for soil characterization under the ROD. The rest of the borings were used for TPH-diesel characterization. The results were used to identify contaminated areas for subsequent removal. TPH removal actions and demolition were conducted at Buildings 181 and 804 (U.S. Navy

1999d and 2000c). Results of the subsequent independent remedial actions for diesel contamination are described in separate remedial action closure reports for TPH removal and demolition at Buildings 181 and 804 (U.S. Navy 1999d and 2000c).

Detailed discussions of the delineation program and sampling results can be found in the final closure report for Building 72 demolition and hot spot soil removal (U.S. Navy 1999d). In general, 7 inorganic and 19 organic compounds were detected in subsurface soils during the delineation program. Of the seven detected inorganics, only cadmium (six locations) and chromium (three locations) exceeded the ROD action levels. The delineation sampling results were used to define the hot spot areas.

The soil hot spot removal action was conducted in two phases in July 1998 and March 1999. In accordance with the ROD, cadmium- and chromium-contaminated soil was removed to groundwater level at 9 feet bgs. The hot spot areas were excavated and backfilled with imported clean material the same day. Contaminated soil was transported and disposed of at Waste Management in Arlington, Oregon. Overall, 1,100 tons of metal-contaminated soil were excavated from the hot spot areas and properly disposed of.

Monitoring. Four new groundwater monitoring wells were installed in 1995 to support the post-ROD groundwater monitoring program. The first round of post-ROD groundwater monitoring at Area 8 was conducted in fall 1995, and groundwater monitoring has been ongoing since that time. Sediment and tissue monitoring in the intertidal zone of Area 8 has been conducted approximately every 4 years since 1996, with the most recent event in summer 2008. Monitoring is discussed further in Section 4.2.4.

Contingent Groundwater Control Actions. No action has been taken to control the movement of groundwater from Area 8 to Liberty Bay, based on evaluations of the data set for sediment and clam tissue. The need for contingent groundwater control actions is discussed in Section 7.2.2, based on the results of the most recent sediment and tissue sampling and subsequent risk assessment.

Institutional Controls. The institutional controls management plan discussed in Section 4.1.3 covers Area 8 and satisfies the institutional controls component of the remedy. Institutional controls at Area 8 are used to prevent residential land use, prevent construction of potable groundwater wells, restrict construction activities, allow for LTM, and control physical access to the property until the soil removal component of the remedy was completed.

4.2.4 OU 2 Operation, Maintenance, and Monitoring

Area 2 Monitoring

Groundwater monitoring has been conducted at Area 2 since 1995, with annual sampling events historically occurring in the fall. Between 1996 and 1999, three groundwater monitoring wells (2MW-1, 2MW-5, and 2MW-6) were sampled. Following a discussion with Ecology in 2000, the upgradient well (2MW-5) was dropped from the program and replaced with MW2-6. VOCs were not detected at well MW2-6 during the 2000 sampling event. Therefore, the Navy and Ecology agreed to replace MW2-6 with well MW2-8 beginning with the 2001 sampling event. Beginning in 2002, the sampling season was changed from fall to spring to coordinate with other sampling activities at Area 8 and OU 1.

All Area 2 monitoring activities since the last 5-year review were performed in accordance with the LTM work plan and included annual sampling of three monitoring wells (2MW-1, 2MW-6, and MW2-8) for VOCs. Furthermore, the current monitoring frequency meets the requirements specified in the ROD. The work plan was revised in 2004, 2006, and 2007 (U.S. Navy 2004a, 2006a, and 2007a). However, the Area 2 monitoring program remained largely unchanged during this period. Sampling groundwater wells for 1,4-dioxane was added as a one-time sampling event in the 2006 work plan, with sampling occurring in 2007. Otherwise, no other changes were made to the monitoring program since the last 5-year review. Groundwater monitoring locations are shown on Figure 4-3.

Institutional controls inspections and reporting for Area 2 have been performed concurrently with those for OU 1, as described in Section 4.1.4.

Area 8 Monitoring

Monitoring at Area 8 has been conducted since the signing of the ROD and has included groundwater, sediment, and tissue sampling and analysis. During the first round of post-ROD sampling in 1995, groundwater samples were analyzed for SVOCs in addition to VOCs and metals as specified in the ROD. The SVOC results from that sampling round showed only one compound detected above the MTCA Method B cleanup level: bis(2-ethylhexyl)phthalate. Two other detections of SVOCs were extremely low. The first-round post-ROD monitoring report (U.S. Navy 1996c) concluded that SVOCs were not a significant problem in the groundwater at Area 8, and analysis for SVOCs in groundwater was discontinued with the concurrence of all interested parties.

Additional modifications to the monitoring program were implemented beginning in 2000. Seep sampling was added to the monitoring program and groundwater sampling frequency was reduced from twice annually to annually in 2000. Chromium speciation was discontinued after

the 2000 sampling event. Modifications were also made to the sampling program by the Navy and Ecology (U.S. Navy 2002d) after the first 11 rounds of sampling (up through 2001). The two upgradient wells were dropped from the list of wells sampled. One-time sampling of wells MW8-10 and MW8-15 was added, with analysis for VOCs. One sample was to be collected from well MW8-12 and analyzed for cyanide, and then cyanide was dropped from the analyte list for all media. Also in 2002, monitoring was added in the area of an independent remedial action undertaken by the Navy within Area 8 (U.S. Navy 2002d). During the removal action, petroleum-contaminated soil was removed from around and beneath two petroleum USTs. The additional monitoring consisted of the following:

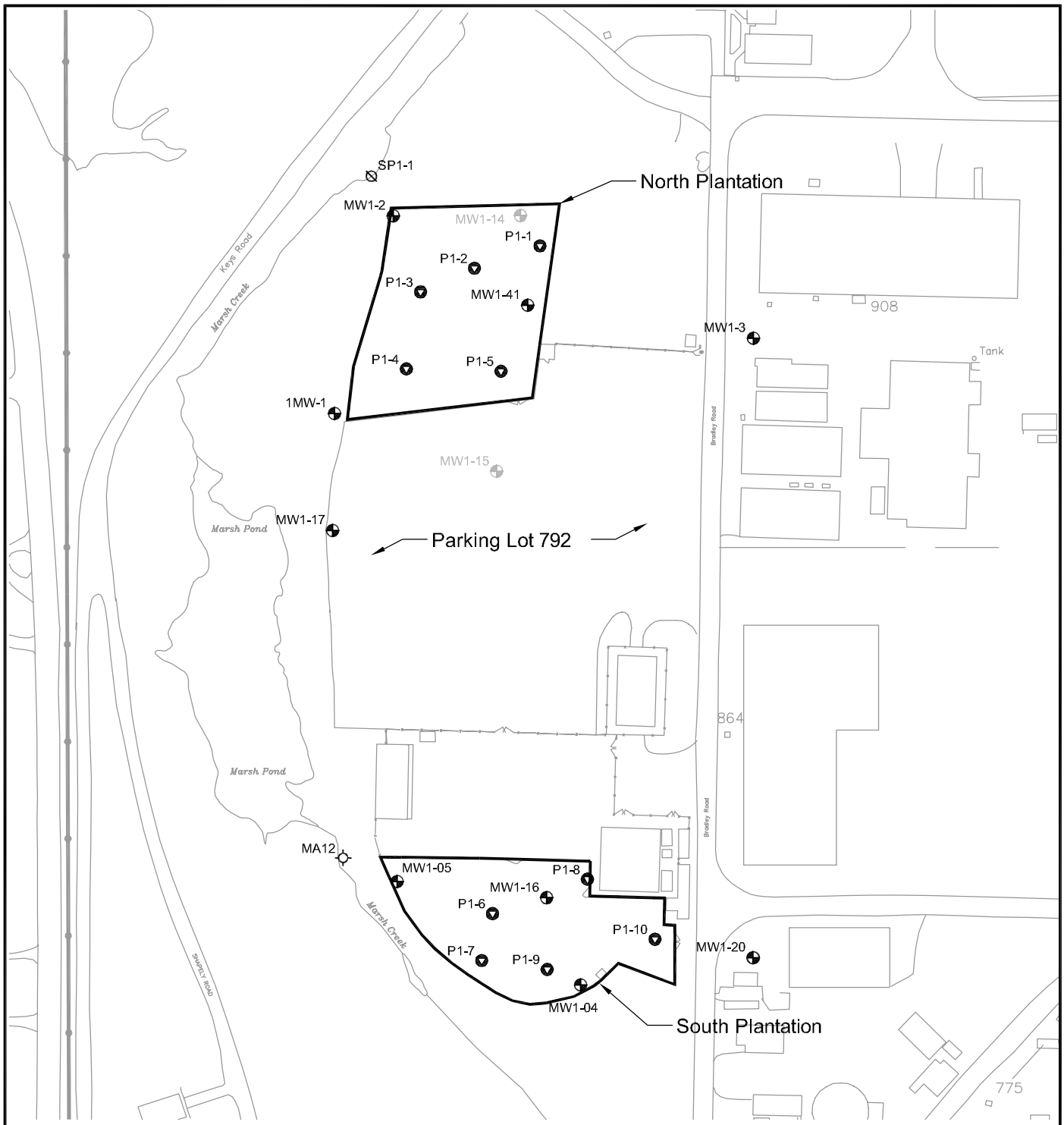
- Sampling wells MW8-2 and MW8-9 for TPH as heavy oil (TPH-heavy oil)
- Sampling of Seep A for TPH-heavy oil
- A physical check of the beach immediately north of Seep A to identify any physical evidence of petroleum on the beach

This monitoring, termed "independent remedial action TPH monitoring," was conducted in 2002 and 2004.

All Area 8 monitoring activities since the last 5-year review in 2004 were performed in accordance with the LTM work plan. The work plan was revised in 2004, 2006, and 2007 (U.S. Navy 2004a, 2006a, and 2007a). Two modifications were made to the Area 8 monitoring program during this time period. The independent remedial action TPH monitoring was discontinued in 2006, based on the results of two rounds of sampling (2002 and 2004), with the concurrence of Ecology. In addition, sampling groundwater wells for 1,4-dioxane was added as a one-time sampling event in the 2006 work plan, with sampling occurring in 2007. The current sampling schedule is shown in Table 4-2. Monitoring locations are shown on Figure 4-4.

Institutional controls inspection and reporting for Area 8 have been performed concurrently with those for OU 1, as described in Section 4.1.4.

The results of monitoring conducted since the second 5-year review are summarized in Section 6.4.



LEGEND

- Piezometer (Groundwater Elevations Only)
- Monitoring Well (Groundwater Elevations Only)
- Monitoring Well (Groundwater Elevations and Sampling)
- Seep Sampling Station
- Surface Water Sampling Station

T:\KEYPORT\Sub-Tasks\IDIQ\DO 64\5 yr Review\Fig 4-1 Phyto OU 1.dwg
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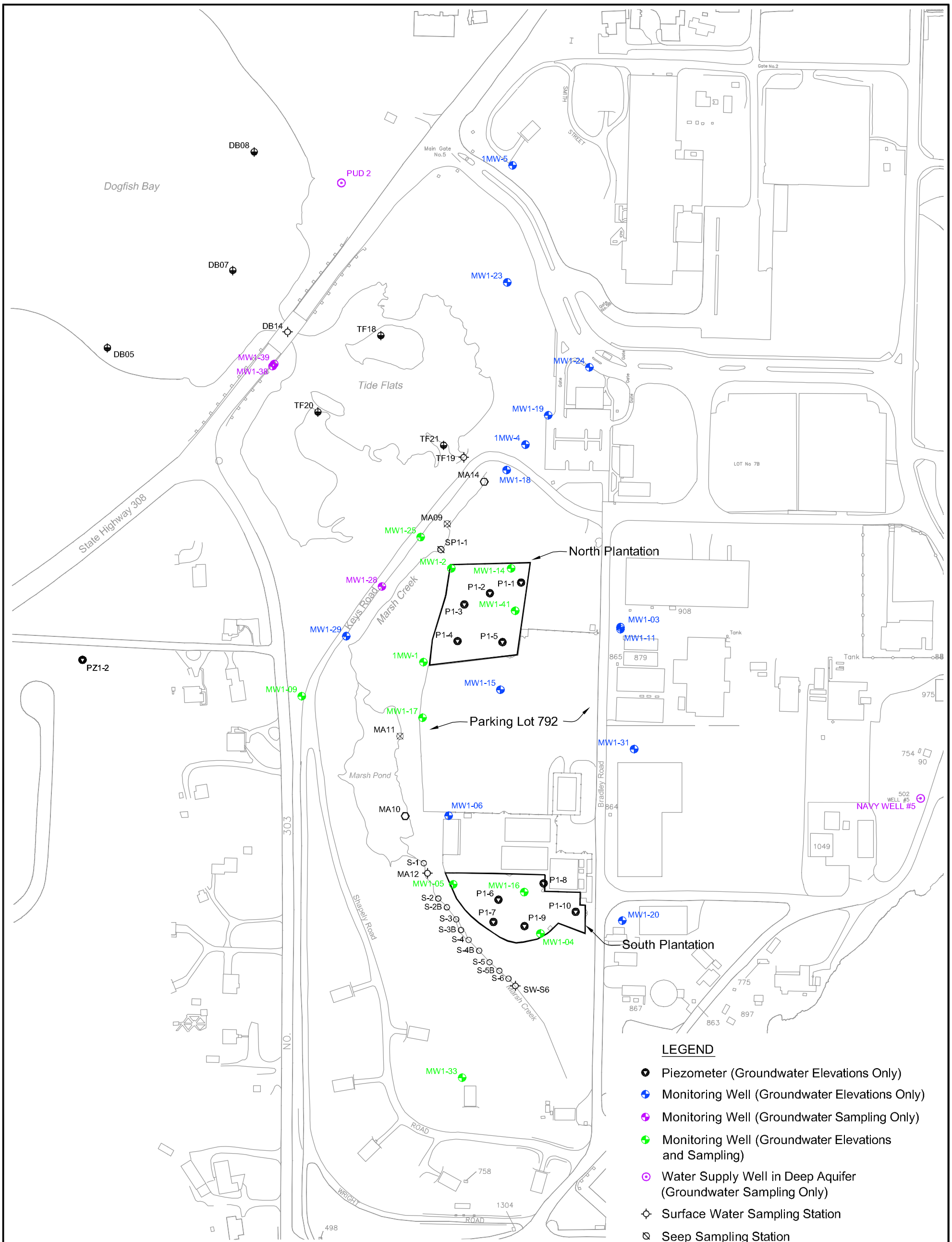
U.S. NAVY	0 75 150 SCALE IN FEET	**Figure 4-1 Phytoremediation Sampling Locations at OU 1**	NBK Keyport THIRD FIVE-YEAR REVIEW



LEGEND

- Piezometer (Groundwater Elevations Only)
- Monitoring Well (Groundwater Elevations Only)
- Monitoring Well (Groundwater Sampling Only)
- Monitoring Well (Groundwater Elevations and Sampling)
- Water Supply Well in Deep Aquifer (Groundwater Sampling Only)
- Surface Water Sampling Station
- Seep Sampling Station
- Sediment Sampling Station
- Sediment and Tissue Sampling Station
- Sediment and Surface Water Sampling Station
- Passive-Diffusion Sampler Site

Notes:

1. MA10 is a historical sampling location. It is not part of the current monitoring program.
2. All passive-diffusion sampler sites and surface water sampling station SW-S6 were sampled as part of the intrinsic bioremediation monitoring program, not the risk and compliance monitoring program.
3. MW1-33 was sampled as part of the intrinsic bioremediation monitoring program, not the risk and compliance monitoring program.

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Figure 4-2
Risk and Compliance Long-Term Monitoring Sampling Locations at OU 1

NBK Keyport
THIRD FIVE-YEAR REVIEW

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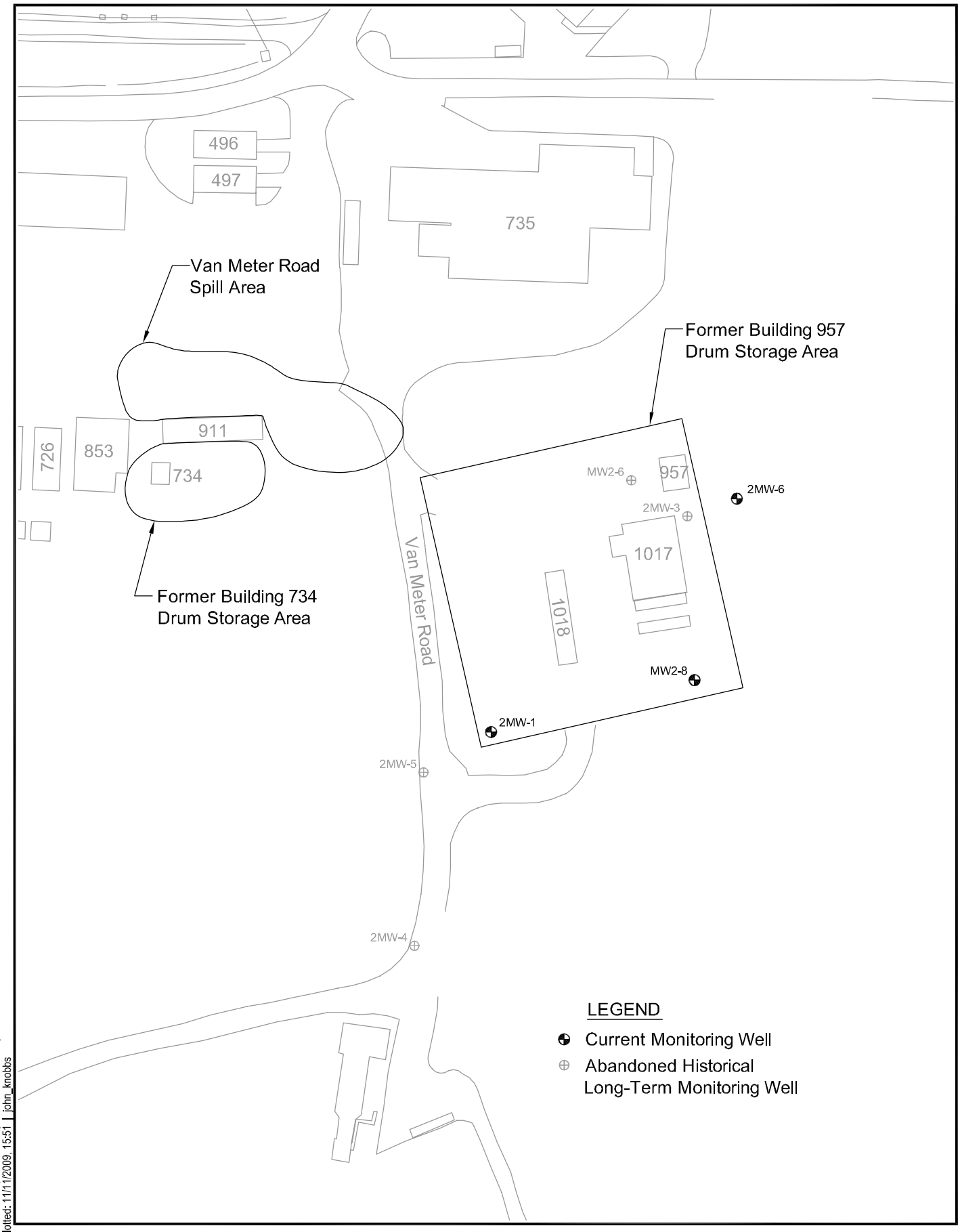

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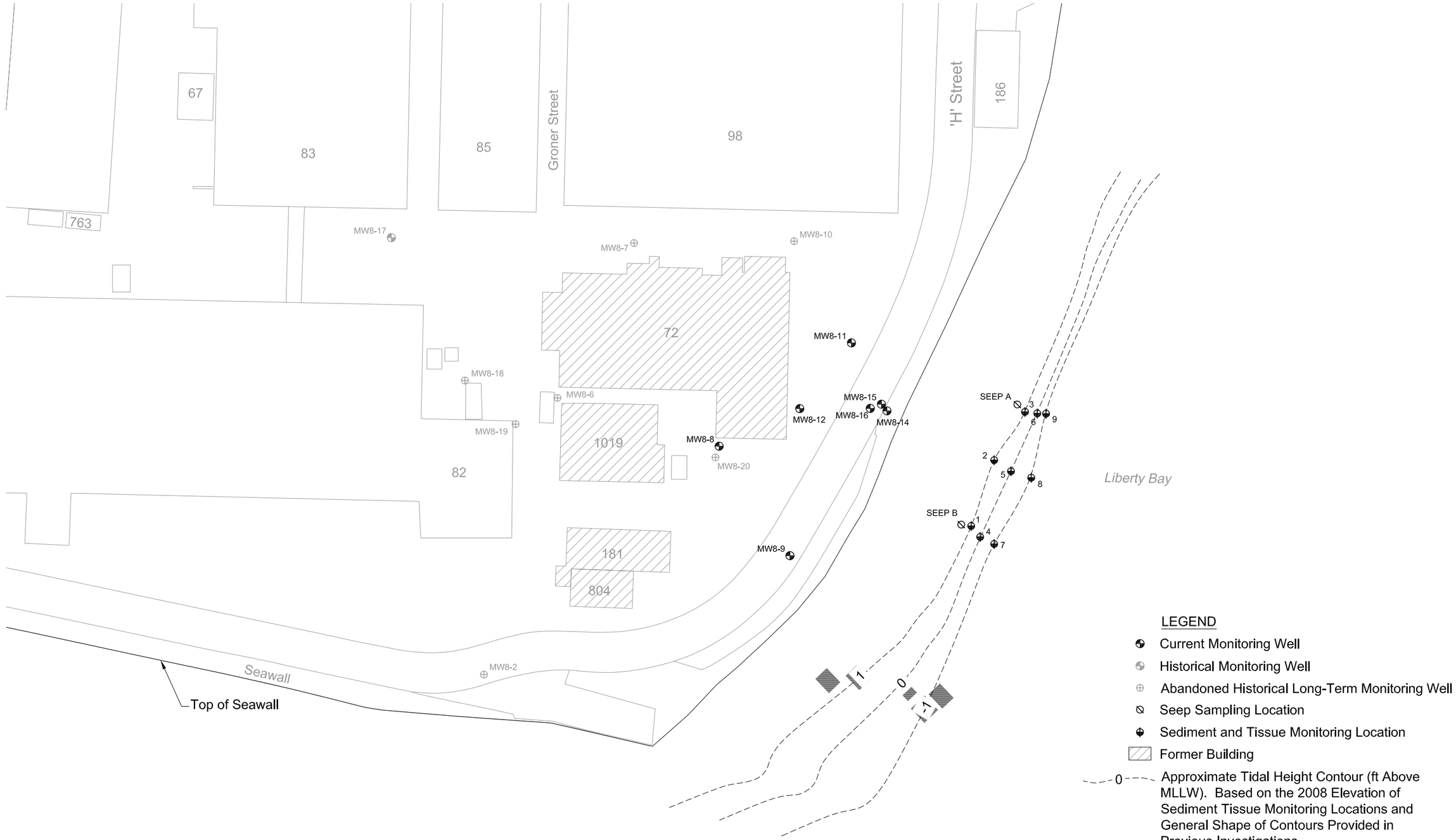
U.S. NAVY	0 50 100 SCALE IN FEET	**Figure 4-3** **Groundwater Long-Term Monitoring Locations at OU 2 Area 2**	NBK Keyport THIRD FIVE-YEAR REVIEW



Note:
Well MW8-2 was only sampled in 2002 and 2004 for TPH-heavy oil as part of an independant remedial action. Sampling was discontinued based on the results of the two rounds of sampling, with the concurrence of Ecology.

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Figure 4-4
Long-Term Monitoring Locations at OU 2 Area 8

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Table 4-1
Sampling Locations, Frequencies, and Analytical Requirements for OU 1 Monitoring

Sampling Location	Sampling Program	Sampling Frequency				Analytes				
		Twice/ Year	Once/ Year	Once/2 Years[a]	Once/5 Years[b]	VOCs	1,4-Dioxane[c]	SVOCs	PCBs, Pesticides	Metals[d]
Upper Aquifer Wells										
1MW-1	LTM, Phyto	X				X	X			
MW1-2	LTM, Phyto	X				X	X			
MW1-3	Phyto	X				X	X			
MW1-4	LTM, Phyto	X				X	X			
MW1-5	LTM, Phyto	X				X	X			
MW1-16	LTM, Phyto	X				X	X			
MW1-17	LTM		X			X	X			
MW1-20	Phyto	X				X	X			
MW1-41	LTM, Phyto	X				X	X			
Intermediate Aquifer Wells										
MW1-9	LTM, CRA			X		X	X			
MW1-25	LTM			X		X	X			
MW1-28	LTM			X		X	X			
MW1-38	LTM, CRA			X		X	X			
MW1-39	LTM, CRA			X		X	X			
Deep Wells										
PUD	LTM		X			X	X			
Navy #5	LTM		X			X	X			
Seep										
SP1-1[e]	LTM, Phyto		X	X		X			X	
Surface Water										
DB-14	LTM		X			X				
TF-19	LTM		X			X				
MA-09	LTM		X			X				
MA-11	LTM		X			X				
MA-12	LTM, Phyto	X				X				

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

Sampling Location	Sampling Program	Sampling Frequency				Analytes				
		Twice/ Year	Once/ Year	Once/2 Years[a]	Once/5 Years[b]	VOCs	1,4-Dioxane[c]	SVOCs	PCBs, Pesticides	Metals[d]
Sediment										
MA-09	LTM				X			X	X	X
MA-11	LTM				X			X	X	X
MA-14	LTM				X			X	X	X
TF-18	LTM				X			X	X	X
TF-20	LTM				X			X	X	X
TF-21	LTM				X			X	X	X
DB-05	LTM				X			X	X	X
DB-07	LTM				X			X	X	X
DB-08	LTM				X			X	X	X
Tissue (Clams)										
TF-18	LTM				X			X	X	X
TF-20	LTM				X			X	X	X
TF-21	LTM				X			X	X	X
DB-05	LTM				X			X	X	X
DB-07	LTM				X			X	X	X
DB-08	LTM				X			X	X	X

[a]The last 2-year sampling event occurred in 2008.
[b]The last 5-year sampling event occurred in 2009.
[c]1,4-dioxane was analyzed for in groundwater as part of a one-time sampling event in 2006.
[d]Metal analyses include arsenic, beryllium, chromium, lead, mercury, nickel, and zinc.
[e]SP1-1 is sampled once every 2 years for PCBs and twice per year for VOCs. The last 2-year PCB sampling event occurred in 2008.

Notes:
CRA - contingent remedial action monitoring program
LTM - long-term monitoring program
PCBs - polychlorinated biphenyls
Phyto - phytoremediation monitoring program
SVOCs - semivolatile organic compounds
VOCs - volatile organic compounds

Table 4-2
Sampling Locations, Frequencies, and Analytical Requirements for OU 2 Area 8 Monitoring

Sampling Location	Sampling Frequency		Analysis					
	Once/ Year	Once/5 Years	VOCs	1,4-Dioxane[a]	Dissolved Metals	Total Metals	pH-Heavy Oil	SVOCs[b]
Groundwater Monitoring Wells								
MW8-8	X		X	X	X			
MW8-9	X		X	X	X			
MW8-11	X		X	X	X			
MW8-12	X		X	X	X			
MW8-14	X		X	X	X			
MW-8-16	X		X	X	X			
MW8-15[c]	X							
Seeps								
Seep A	X		X		X			
Seep B	X		X		X			
Sediment and Tissue								
1		X				X		X
2		X				X		X
3		X				X		X
4		X				X		X
5		X				X		X
6		X				X		X
7		X				X		X
8		X				X		X
9		X				X		X
		X				X		X
Independent Remedial Action TPH Monitoring[d]								
MW8-2		X					X	
MW8-9		X					X	
Seep A		X					X	
Physical Check		X					X	

[a]1,4-dioxane was analyzed for in groundwater as part of a one-time sampling event in 2007.
[b]Semivolatile organic compound (SVOC) analyses include phenol.
[c]Groundwater-level measurement will be conducted at MW8-15, but no environmental sample will be collected for MW8-15.
[d]Total petroleum hydrocarbon (TPH) monitoring was conducted once in 2004. Ecology has agreed that further monitoring of TPH is not necessary.

Note: VOCs - volatile organic compounds

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 completed all of the actions recommended by the last 5-year review with the exception of those expected to be ongoing.

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

Recommendation/Follow-up Action From Second 5-Year Review (December 2005)	Completion Date	Notes Regarding Completion	Reference
Revise the institutional controls management plan to include Site 23.	July 2009	Published a revised institutional controls management plan that includes Site 23.	U.S. Navy 2009a
Discontinue independent remedial action petroleum monitoring at OU 2 Area 8.	2005	Based on U.S. Environmental Protection Agency concurrence with second 5-year review	USEPA 2005
Continue long-term monitoring programs as currently established at OU 1 and OU 2, including sediment and shellfish monitoring.	Ongoing	Monitoring conducted during this 5-year review period meets or exceeds Record of Decision requirements.	Sections 4.1.4 and 4.2.4
Perform further investigation of the aquatic biota in Liberty Bay offshore from OU 2 Area 8 to assess possible impacts from cadmium.	May 2009	Performed ecological risk evaluation of intertidal zone at Area 8.	U.S. Navy 2009b
During the next 5-year review, assess the protectiveness of the remediation goal for TCE, considering the final revised value for the TCE oral slope factor.	2010	Evaluated as part of this third 5-year review	Section 7.2.2
Sample for the presence of 1,4-dioxane in groundwater at OU 1 and OU 2 Area 8 and report the results.	2006-2007	Included as a one-time event in the 2006 work plan, with sampling in 2006 (OU 1) and 2007 (OU 2)	U.S. Navy 2006a
Monitor any increasing chemical of concern concentration trends at OU 2 Area 8 over the next 4 years and, if necessary, determine the cause and provide recommendations for action.	2009	Evaluated as part of this third 5-year review	Sections 6.4 and 7.3

Note: TCE - trichloroethene

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, Naval Base Kitsap, and NBK Keyport 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 RODs for NBK Keyport. 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, for certain reports to be released to the public and the public notified of proposed cleanup plans and remedial actions. The community notification and involvement activities are described below.

6.2.1 History of Community Involvement

The Navy has maintained an ongoing commitment to community involvement since the time of the first investigations at NBK Keyport. The community has been informed of progress at the site through fact sheets, published public notices, open houses, public meetings, and bus tours of the sites. The proposed plans were circulated for public comment prior to finalization of the RODs. The community had substantial input into the remedy for the former landfill, causing the Navy to re-evaluate the proposed plan and segregate OUs 1 and 2. Key documents have been made available for review at Navy facilities and at the Kitsap Regional Library in Bremerton, Washington, and the Poulsbo Branch Library in Poulsbo, Washington.

A community relations plan was prepared in 1990 and most recently updated in 2008. In 1988, a Technical Review Committee (TRC) was established, with representatives from the public and governmental entities. The TRC was replaced with a Restoration Advisory Board (RAB) in March 1995. The RAB members included representatives of the Navy, regulatory agencies, civic groups, private citizens, tribal governments, local governments, and environmental activist groups. The RAB was disbanded in October 2004.

6.2.2 Community Involvement During the Five-Year Review

A notice was published by the Navy on November 8, 2009, in the *Kitsap Sun* informing the public that the site is currently undergoing a 5-year review, when, where, and how they could receive information, and how to provide comments on the protectiveness of the remedy. The

Navy received no feedback or comments as a result of the public notices. Selected community members were interviewed as part of the site interview process described in Section 6.6.

6.3 DOCUMENT REVIEW

Documents reviewed during this 5-year review were primarily those describing monitoring of the selected remedies during the time period June 2004 to June 2009. The primary documents that were reviewed are listed below:

- The signed RODs (U.S. Navy, USEPA, and Ecology 1994 and 1998)
- The first and second 5-year review reports (U.S. Navy 2000b and 2005a)
- The LTM work plans (U.S. Navy 2002d, 2004a, 2006a, and 2007a)
- The monitoring reports (U.S. Navy 2009c, 2009d, 2009e, 2009f, 2009g, 2009h, 2008a, 2008b, 2008c, 2008e, 2007b, 2007c, 2007d, 2007e, 2006b, 2005b, 2005c, 2003c, 2002e, 2001b, 2001c, 1996c, and 1996d)
- The intrinsic bioremediation reports (Dinicola and Huffman 2009, 2007, and 2006)
- The RI report (U.S. Navy 1993)
- The revised operation and maintenance plan for phytoremediation at OU 1 (U.S. Navy 2003b)
- The contingent remedial action plan (U.S. Navy 2003a)

6.4 DATA REVIEW

This section summarizes trends in data collected through the various monitoring programs at NBK Keyport, with emphasis on data collected since the last 5-year review. The monitoring programs are described in Section 4, and the implications of the data with respect to the functionality and protectiveness of the remedies are discussed in Section 7.

The data trends are discussed in the sections that follow by OU, area, and medium.

6.4.1 OU 1 Monitoring Data

OU 1 Groundwater Monitoring Data

At Area 1, groundwater concentration trends for the target VOCs, including TCE, cis-1,2-DCE , trans-1,2-DCE, 1,1-DCE, vinyl chloride, 1,1,1-TCA, and 1,1-dichloroethane (1,1-DCA), have been tracked at sampling locations where chemicals have been detected historically: 1MW-1, MW1-2, MW1-3, MW1-4, MW1-5, MW1-16, and MW1-17. Since the last 5-year review, VOCs have been consistently detected in most of the monitoring wells located within or downgradient of the former landfill area. Concentrations of some of the target VOCs (1,1-DCE, cis-1,2-DCE, and vinyl chloride) exceeded the RGs in six or more wells over the same time period. However, target VOCs in the north plantation, south plantation, central landfill area, and the deep aquifer wells have generally exhibited either stable or decreasing trends since the last 5-year review, with the exception of one upper aquifer well within the central landfill area (U.S. Navy 2009c and 2008a). VOC concentrations remain highest in groundwater beneath the south plantation. Historical and recent groundwater monitoring data for VOCs at OU 1 are summarized in Table 6-1 and discussed in the sections that follow. Sampling locations are shown on Figure 4-2.

At the request of Ecology, the Navy also analyzed groundwater samples from the 16 monitoring wells for 1,4-dioxane as a one-time sampling event in July 2006 (see Table 6-2). 1,4-Dioxane was detected in 8 of the 16 wells at concentrations ranging from 1 to 29 µg/L. Generally, 1,4-dioxane was detected in the north plantation or downgradient of the north plantation. It was not detected in the south plantation. No RG is established for 1,4-dioxane. However, the current MTCA Method B cleanup level is 4 µg/L (see Section 7.2.1), which was exceeded in wells MW1-2, MW1-25, MW1-28, MW1-38, and MW1-41.

North Plantation. Upper aquifer wells monitored in the vicinity of the south plantation included 1MW-1, MW1-2, MW1-3, and MW1-41. Upgradient well MW1-3 continued to exhibit undetected or very low concentrations of VOCs since the last 5-year review. Well MW1-41, located in the middle of the north plantation, also exhibited undetected or very low levels of VOCs. Upper aquifer wells downgradient of the north plantation, 1MW-1 and MW1-2, showed elevated VOC concentrations with stable or slightly decreasing trends over this 5-year review period, with the exception of the spring 2005 sampling results for 1MW-1, which were unusually low. Vinyl chloride continued to exceed its RG in both wells, and 1,1-DCE, cis-1,2-DCE, and TCE continued to exceed their RGs in well MW1-2. During this 5-year review period, intermediate aquifer wells downgradient of the north plantation, MW1-25 and MW1-28, exhibited high and relatively stable concentrations of cis-1,2-DCE and vinyl chloride. Concentrations of these two VOCs and 1,1-DCE continued to exceed their RGs in MW1-25 and MW1-28. Farther downgradient, intermediate aquifer well MW1-39 showed only trace

concentrations of vinyl chloride during this 5-year review period, while well MW1-38 showed no VOC detections.

The following recommendations regarding the monitoring program are based on these sampling results:

- Monitoring of MW1-41 should be discontinued, because concentrations of VOCs have been very low or undetected over the last 5 years with no exceedance of RGs since 2001.

- The monitoring frequency for wells upgradient, within, or downgradient of the north plantation used in the phytoremediation monitoring program (1MW-1, MW1-2, and MW1-3) should be reduced to once every 2 years, based on stable or decreasing concentrations in these wells. Even with this reduced schedule of monitoring, the monitoring frequency still exceeds the requirements in the OU 1 ROD, which specifies that phytoremediation monitoring occur once every 5 years for 10 years after remedy implementation.

- The monitoring frequency for the two intermediate aquifer wells, MW1-38 and MW1-39, should remain unchanged at once every 2 years to meet the requirements of the contingent remedial action plan (U.S. Navy 2003a).

South Plantation. Upper aquifer wells monitored in the vicinity of the north plantation included MW1-4, MW1-5, MW1-16, and MW1-20. Upgradient well MW1-20 continued to exhibit undetected or very low concentrations of VOCs since the last 5-year review. Well MW1-16, located within the south plantation, has historically had high concentrations of 1,1-DCA and vinyl chloride and low concentrations of other VOCs, with all VOCs exhibiting decreasing trends. Over the last 5 years, 1,1-DCA concentrations have not exceeded the RG, with the exception of one high detection in October of 2006. Vinyl chloride concentrations have exhibited high variability since monitoring began in 1995, although generally concentrations are lower than when monitoring began. Also within the south plantation, upper aquifer well MW1-4 exhibited very high concentrations of TCE, cis-1,2-DCE, and vinyl chloride, with the most recent sampling results from 2009 close to the highest values ever detected at this well. As with the vinyl chloride concentrations in MW1-16, the TCE, cis-1,2-DCE, and vinyl chloride concentrations in well MW1-4 have exhibited high variability since monitoring began in 1995, with no clear concentration trend evident in this well. Finally, upper aquifer well MW1-5, located downgradient of the south plantation, exhibited relatively low and stable VOC concentrations since the last 5-year review. However, concentrations of 1,1-DCE, TCE, and vinyl chloride in some groundwater samples from this well collected during this 5-year review period exceeded the RG. 1,1-DCE slightly exceeded the RG in June of 2009, TCE exceeded the RG in April of 2005, and vinyl chloride has exceeded the RG during all but one sampling event.

Changes to the groundwater monitoring program are not recommended for the south plantation because of high VOC concentrations detected in well MW1-4, exceedances of RGs in all wells except the upgradient well, and the high variability in concentrations in wells MW1-4 and MW1-16. Therefore, no changes to the monitoring frequency are recommended for wells MW1-4, MW1-5, MW1-16, and MW1-20.

Central Landfill Area. VOC concentrations detected in well MW1-17 located downgradient of the central portion of the landfill have historically been low and below the RGs, with the exception of vinyl chloride. However, during the last 5 years, concentrations of 1,1-DCE, cis-1,2-DCE, and vinyl chloride have increased, with the highest detected concentrations occurring in June 2009 for all three compounds. The June 2009 concentrations of cis-1,2-DCE and vinyl chloride exceeded the RGs. The intermediate aquifer well MW1-9, downgradient of the central landfill area and south plantation, has exhibited no detections of VOCs since monitoring began in 1995.

Changes to the monitoring program are not recommended for the central landfill area wells. Concentrations of VOCs in well MW1-17 have been increasing over the last 5 years. Therefore, it is recommended that monitoring in this well be continued on an annual basis. Although VOCs have not been detected in intermediate aquifer well MW1-9, this well is a sentinel well in the contingent remedial action plan and must be sampled once every 2 years.

Deep Aquifer. Two wells (Navy Well #5 and the Kitsap County PUD well) screened in the deep aquifer were sampled annually since the last 5-year review. Target VOCs were not detected in these two wells during any sampling event (U.S. Navy 2008a and 2009c). The OU 1 ROD requires that these wells be monitored once a year. Therefore, it is recommended that monitoring of these wells be continued on an annual basis.

Summary of OU 1 Groundwater Monitoring Recommendations. As discussed above, the following are the recommended changes to the groundwater monitoring program:

- Discontinue monitoring well MW1-41.
- Reduce the monitoring frequency in wells 1MW-1, MW1-2, and MW1-3 to once every 2 years.
- Reduce the monitoring frequency in wells MW1-25 and MW1-28 to once every 5 years.

These recommended changes to OU 1 monitoring will be considered during overall revisions to the OU 1 LTM plan recommended by this 5-year review (Section 8).

OU 1 Surface Water and Seep Monitoring Data

At Area 1, surface water and seep concentration trends for the target VOCs, including TCE, cis-1,2-DCE , trans-1,2-DCE, 1,1-DCE, vinyl chloride, 1,1,1-TCA, and 1,1-DCA, have been tracked at sampling locations where chemicals have been detected historically: DB-14, MA-09, MA-11, MA-12, SP1-1, and TF-19. VOC concentrations have declined to less than the RGs at all sampling locations except MA-12, which is just downgradient of the south plantation (U.S. Navy 2008a and 2009c). Historical and recent surface water monitoring data for OU 1 are summarized in Table 6-3. Sampling locations are shown on Figure 4-2.

Concentrations of VOCs in DB-14, MA-09, MA-11, SP1-1, and TF-19 were either undetected or detected at very low levels over the last 5 years, and as discussed above, concentrations were all below the RGs. However, MA-12 continued to exhibit concentrations of 1,1-DCE, TCE, and vinyl chloride above the RGs since the last 5-year review. Furthermore, results from the most recent sampling event in 2009 were close to the highest values ever detected at this location. Concentrations of 1,1-DCE, TCE, and vinyl chloride have exhibited high variability since monitoring began in 1996, with no clear concentration trend evident at this location.

Based on these sampling results, it is recommended that monitoring frequency at DB-14, SP1-1, and TF-19 be reduced to once every 5 years, which is consistent with the requirements of the ROD. However, no changes to the monitoring frequency are recommended at location MA-12. Because of the remaining high concentrations of VOCs in the south plantation and the continuing exceedances of RGs at MA-12, additional surface water monitoring is recommended, as discussed in the intrinsic bioremediation program below, together with continued annual monitoring at MA-09 and MA-11.

In addition to VOCs, seep SP1-1 is also monitored for PCBs every other year. The PCB monitoring data are presented in Table 6-4. Following implementation of remedial actions at the site, including removal of approximately 75 tons of sediments during the summer of 1999 from the creek located downgradient from the landfill, total PCBs concentrations at seep location SP1-1 have decreased from 0.45 µg/L in June 2002 to 0.27 in May 2008. However, concentrations remain above the RG of 0.04 µg/L (U.S. Navy 2008a). Because concentrations of PCBs are decreasing in SP1-1, it is recommended that monitoring frequency be decreased to once every 5 years. This monitoring frequency is consistent with the requirements of the OU 1 ROD.

In summary, it is recommended that monitoring for VOCs in DB-14, SP1-1, and TF-19 and monitoring for PCBs in SP1-1 be reduced to once every 5 years. However, no change to the monitoring frequency is recommended at locations MA-12, MA-09, and MA-11. These recommended changes to OU 1 monitoring will be considered during overall revisions to the OU 1 LTM plan recommended by this 5-year review (Section 8).

OU 1 Intrinsic Bioremediation Monitoring Data

For 2007 and 2008, predominant redox conditions in the upgradient wells in the upper aquifer (wells MW1-3 and MW1-20) ranged from aerobic to mildly reducing (nitrate reduction and manganese and iron reduction). These wells have varied between aerobic and sulfate reducing during the past 10 years of monitoring. Redox conditions in the upgradient well MW1-33 have been consistently aerobic during the same time period (Dinicola and Huffman 2009).

For the upper aquifer beneath the northern plantation in 2007 and 2008, the strongly reducing conditions (sulfate reduction and methanogenesis) most favorable for reductive dechlorination of VOCs were identified in five of the eight upper aquifer wells and piezometers. The other upper aquifer wells and piezometers within the north plantation had iron-reducing or unspecified anaerobic conditions. For the upper aquifer beneath the south plantation in 2007 and 2008, the strongly reducing conditions were identified in four of the eight upper aquifer wells and piezometers. The other upper aquifer wells and piezometers in the south plantation had manganese and/or iron reducing conditions.

Overall, except for the apparent trend toward lower dissolved hydrogen concentrations in the upper aquifer beneath the two plantations, no widespread changes in groundwater redox conditions were identified that should result in either more or less efficient biodegradation of chlorinated VOCs. Dissolved hydrogen concentrations, measured in the upper aquifer during 2007 and 2008, have generally been lower than the concentrations measured before 2002. However, widespread and relatively high methane and sulfide concentrations indicate that the lower dissolved hydrogen concentrations measured do not indicate a trend from strongly to mildly reducing redox conditions.

Predominant redox conditions in all intermediate aquifer wells downgradient of the landfill have been consistently anaerobic. Mildly reducing conditions (iron reduction) were indicated for the intermediate aquifer wells at the downgradient margin of the landfill in wells MW1-25 and MW1-28. The mildly reducing conditions are somewhat favorable for reductive dechlorination.

In general, results of the latest intrinsic biodegradation sampling in June 2009 are consistent with sampling conducted in 2007 and 2008, with no dramatic changes in redox conditions (Dinicola 2009). In addition, no dramatic changes in redox conditions were observed in 2007 and 2008 when compared to the 2005 and 2006 (Dinicola and Huffman 2006 and 2007). Although no dramatic changes have been observed, the general trend over the 5-year-review period is toward an increasing percentage of the upper aquifer wells within the plantation areas exhibiting strongly reducing redox conditions.

For the upper aquifer beneath the north phytoremediation plantation, chlorinated VOC concentrations in 2007 and 2008 at most piezometers were similar to or slightly less than chlorinated VOC concentrations measured in previous years (Dinicola and Huffman 2009). In addition, the sum of the concentrations of ethane and ethene, which are reductive dechlorination byproducts, was at the highest level measured at most north plantation wells and piezometers. This is indicative of reductive dechlorination of chlorinated VOCs. In general results of the June 2009 sampling are consistent with the 2007 and 2008 results (Dinicola 2009). However, concentrations of total chlorinated VOCs in P1-3 increased from 10 µg/L in 2008 to 182 µg/L in 2009.

For the upper aquifer beneath the south phytoremediation plantation, chlorinated VOC concentrations in 2007 and 2008 at the piezometers were extremely high and they continued to vary considerably over space and time (Dinicola and Huffman 2009). At piezometer P1-6, the total chlorinated VOC concentration increased from 380 µg/L in 2007 to more than 20,000 µg/L in 2008. At piezometer P1-7 in 2008, the concentrations of TCE, cis-DCE, and vinyl chloride were the highest to date, but total chlorinated VOC concentrations at piezometers P1-8, P1-9, and P1-10 in 2008 were relatively low compared to historical levels. Results for 2009 continued to show significant variability (Dinicola 2009). Concentrations of VOCs at P1-6, P1-8, and P1-10 showed considerable decreases compared to 2008. Meanwhile, the total chlorinated VOC concentration at P1-7 reached an all time high, and the total chlorinated VOC concentration at piezometer P1-9 increased from a level of 25,000 µg/L in 2008 to 172,000 µg/L in 2009. The magnitude and persistence of chlorinated VOC concentrations indicate that nonaqueous-phase liquid chloroethenes are likely present beneath the south plantation, and the temporal variability in concentrations is likely a result of variations in precipitation and groundwater levels interacting with the nonaqueous-phase liquid (Dinicola and Huffman 2009). The reductive dechlorination byproducts ethane and ethene were detected at all wells and piezometers in the south plantation, which is reliable evidence of reductive dechlorination of dissolved VOCs.

For the intermediate aquifer, total chlorinated VOC concentrations in 2008 and 2009 at wells MW1-25, MW1-28, and MW1-39 were consistent with previous years (Dinicola and Huffman 2009 and Dinicola 2009). However, vinyl chloride concentrations in 2008 at these wells were the highest measured to date, and the sum of the concentrations of ethane and ethene measured at wells MW1-25 and MW1-28 in 2009 were the highest to date. These data suggest that either the rate of reductive dechlorination of cis-DCE to create vinyl chloride may have increased, or more nonaqueous-phase liquid has dissolved into groundwater.

In 2005, chlorinated VOCs were positively detected at all 10 passive-diffusion sampler sites located beneath the marsh stream adjacent to the south plantation (see Figure 4-2), and the reductive dechlorination end-products ethane and ethene were detected at all passive diffusion sites except S-4B (Dinicola and Huffman 2006). The highest chlorinated VOC concentrations were measured at a site about midway along the sampled stream reach (S-4). The second highest

chlorinated VOC concentrations were measured at site S-5B (about 75 feet upstream of site S-4). At sites S-4B and S-5, located between S-4 and S-5B, concentrations of chlorinated VOCs were substantially less, indicating a non-uniform pattern of VOC migration towards the marsh creek. The total chlorinated VOC concentration in S-4 increased nearly two fold in 2005 compared to 2004. It is not certain that the apparent increase in concentrations is representative of site conditions, largely because the passive-diffusion samplers are not deployed in exactly the same location from year to year. However, the chlorinated VOC concentrations have increased each time the two most contaminated passive-diffusion sampler sites (S-4 and S-5) have been sampled over multiple years. (Note that S-5B has only been sampled once, in 2005.)

In the marsh creek, the 2005 chlorinated VOC concentrations in surface water at location SW-S6 near the upgradient margin of the former landfill were low. Concentrations in the creek increased substantially after flowing past the south phytoremediation plantation to the downstream site (MA-12).

Overall, the 2005 data were consistent with previous findings of substantial biodegradation of chlorinated VOCs in groundwater, together with continued discharge of some chlorinated VOCs to surface water in the marsh creek at concentrations greater than surface water RGs (Dinicola and Huffman 2006). This is in part because of the relatively short distance between the landfill and the adjacent marsh and in part because of the high VOC concentrations remaining beneath the landfill in the vicinity of the south plantation. In addition, attenuation of VOC concentrations is also substantial in surface water as it flows through the marsh to the tide flats (USGS 2002).

Because of the relatively stable redox conditions and VOC concentrations, a reduction in intrinsic bioremediation monitoring frequency for the north plantation wells and piezometers and the north plantation upgradient well (MW1-3) may be warranted. Possible monitoring frequency changes should be considered as part of the assessment of monitored natural attenuation recommended by this 5-year review (see Section 8).

Although redox conditions in the south plantation have been relatively stable over this 5-year review period, continued annual monitoring of the south plantation wells and piezometers and the south plantation upgradient well (MW1-20) is recommended because of the high VOC concentrations and the variability in the concentrations. Because of the magnitude and persistence of chlorinated VOC concentrations in the south plantation and the apparent increasing trend of VOC concentrations in the two most contaminated passive-diffusion sampling sites, annual sampling is recommended for the 10 passive-diffusion sampling sites and surface water location SW-S6. In addition, annual sampling is recommended of a new surface water station half way between MA-12 and SW-S6, just upgradient of passive-diffusion sampler location S-4. The purposes of this additional monitoring are the following:

- To track trends in the groundwater to surface water transport pathway
- To gain a more detailed understanding of the spatial and temporal variations in contaminant transport to the surface from the south plantation
- To provide a more robust data set to allow prompt recognition of changes in contaminant transport with the potential to impact protectiveness

These potential changes to monitoring at the south plantation should be considered as part of the assessment of monitored natural attenuation recommended by this 5-year review (see Section 8).

OU 1 Sediment Monitoring Data

Sediment sampling is conducted periodically and usually at the time of each 5-year review. Data are now available from 1996 (the post-ROD sampling event), 2000, 2002 (limited number of stations), 2004, and 2009 (U.S. Navy 2009c). Samples are collected from nine stations located in three general areas: Dogfish Bay (three locations), the tide flats (three locations), and the marsh creek (three locations). Historical and recent sediment monitoring data for OU 1 are summarized in Table 6-5. Consistent with historical monitoring reporting practices, SVOC and pesticide data are not tabulated in this report because the results are consistently very low or not detected. Sampling locations are shown on Figure 4-2.

During the 2009 sampling events, most sediment samples exhibited very low concentrations of SVOCs. However, 2,4-dimethylphenol slightly exceeded the apparent effects threshold/Puget Sound dredged disposal analysis (AET/PSDDA) criteria in one sample collected from Dogfish Bay (DB-07). During previous sampling events, sediment samples also exhibited very low concentrations of SVOCs, with the exception of phenol. In 2000, the phenol concentration in the field duplicate sample collected at location TF-21 exceeded the sediment quality standard (SQS). Note that phenol was not detected in the environmental sample from TF-21, and the detection limit did not exceed the SQS. The concentrations of phenol in the 2002, 2004, and 2009 samples from these locations were below the screening levels.

The landfill does not appear to be the source of the 2,4-dimethylphenol and phenol exceedances, based on the sporadic nature and the location of the exceedances. If the landfill were the source, detected concentrations of these compounds would be expected to be higher in the sediment samples closest to the landfill. However, 2,4-dimethylphenol has not been detected in any of the other sediment samples collected during any of the sampling events, including at the locations closest to the landfill (MA-11 and MA-09). Although phenol has been detected at other locations, it has not been detected at the two locations (MA-11 and MA-09) closest to the landfill. Furthermore, the RI indicated that phenol is a compound that is commonly detected in the marine environment of Puget Sound (U.S. Navy 1993 and PSEP 1991).

Ecology collects sediment samples annually in Puget Sound as part of its Puget Sound Assessment and Monitoring Program (PSAMP). These data are made available to the public and can be downloaded from Ecology's website (WDOE 2009). Results from this monitoring indicate that both phenol and 2,4-dimethylphenol are frequently detected in sediment samples in Puget Sound. Phenol concentrations over 17,000 µg/kg have been detected in Puget Sound, and 2,4-dimethylphenol concentrations over 300 µg/kg have been detected. The detected concentrations of phenol and 2,4-dimethylphenol at the site are an order of magnitude less than the maximum detected concentrations reported in the PSAMP database. Based on this, SVOCs in sediment are unlikely to be site related, and it is recommended that monitoring for SVOCs in sediment be discontinued.

Only three pesticide compounds were detected at very low concentrations in six of the nine sediment samples collected in 2009. Concentrations ranged from an estimated 0.15 to 8.1 µg/kg. In 2004, 10 pesticide compounds were detected at very low concentrations at 8 of the 9 locations, and in 2000, 7 pesticide compounds were detected at very low concentrations at 4 of the 9 locations. When compared to the 2004 and 2000 sampling events, far fewer compounds were detected in 2009. However, in 1996, only one pesticide compound was detected at very low concentrations at two of the nine locations. Pesticides have been detected at every location sampled during at least one sampling event, with the most frequent detections of pesticides occurring at locations MA-09, MA-14, and TF-21. No SQS and AET criteria have been established for pesticide compounds. Because detected concentrations of pesticides are consistently very low, it is recommended that monitoring for pesticides in sediment be discontinued.

In 2009, sediment samples exhibited concentrations of PCBs lower than screening levels (see Table 6-5). During previous sampling in 1996, 2000, 2002, and 2004, sediment samples exhibited concentrations of PCBs lower than screening levels except in a few instances. The PCB concentration in the field duplicate collected at MA-09 in 1996 exceeded the Puget Sound Estuary Program (PSEP) AET screening level, as did the samples collected at MA-09 and MA-14 in 2000. Note that the environmental sample collected from MA-09 in 1996 did not exceed the screening level. The concentrations of PCBs in the 2002, 2004, and 2009 samples from these locations were all below the screening levels. Because there have been no exceedances of the PCB screening levels over the past 9 years, it is recommended that monitoring for PCBs in sediment be discontinued. However, if changes are made to the landfill, such as removal of the asphalt paving, which may change groundwater flow patterns, then monitoring for PCBs in sediment should be reconsidered.

Concentrations of metals in sediments during the 2009 sampling event were below the screening levels, with the exception of chromium in the sediment sample collected from MA-11 (see Table 6-5). MA-11 is downgradient of the stormwater outfall from the parking lot between the two plantations, and therefore this chromium concentration could be related to parking lot runoff.

The concentration in this sample was compared to the range of concentrations found in solids collected from 92 catch basins in residential, commercial, and industrial areas (Serdar 1993 and Herrera 1995). The concentration of chromium in MA-11 was an estimated 269 mg/kg, which is slightly higher than the range of concentrations detected in the 92 catch basins.

Concentrations of metals during the previous four sampling events did not exceed the screening levels at any sediment sampling location. Concentrations for metals varied between rounds, but their variations were all less than an order of magnitude, except for lead. Lead concentrations were comparable among the five sampling rounds at most locations, except for at DB-07, where the lead concentration increased from 6 mg/kg in 1996 to 129 mg/kg in June 2000 and back down to 5.85 mg/kg in 2009. Overall, no apparent spatial and temporal trends were observed for the metals. Because of the exceedance of the chromium screening level in the sample collected from MA-11, it is recommended that additional samples be collected in the vicinity of MA-11 and in the catch basin upgradient of the stormwater outfall as a one-time sampling event. The purpose of this sampling event is to evaluate if the source of chromium could potentially be the stormwater discharge. Depending on the results of this sampling, modifications to the monitoring program for metals in sediments should be considered.

In summary, it is recommended that monitoring sediments for SVOCs, pesticides, and PCBs be discontinued. Monitoring sediments for metals should be continued. These recommended changes to OU 1 monitoring will be considered during overall revisions to the OU 1 LTM plan recommended by this 5-year review (Section 8). Furthermore, it is recommended that additional samples be collected in the vicinity of MA-11 and in the catch basin upgradient of the stormwater outfall to evaluate the potential source of the elevated chromium concentration in MA-11.

OU 1 Shellfish Monitoring Data

Shellfish tissue sampling is conducted periodically and usually at the time of each 5-year review. Data are now available from 1996 (the post-ROD sampling event), 2000, 2004, and 2009 (U.S. Navy 2009c). Samples are collected from six stations located in two general areas: Dogfish Bay (three locations) and the tide flats (three locations). Historical and recent sediment monitoring data for OU 1 are summarized in Table 6-6. Sampling locations are shown on Figure 4-2.

Low levels of benzo(b)fluoranthene, benzo(k)fluoranthene, phenol, and 2-methylphenol, and relatively high levels of benzoic acid, were detected in tissue samples collected in 2009. Benzoic acid and 2-methylphenol were detected in all six tissue samples. Phenol was detected in three of the six tissue samples and benzo(b)fluoranthene and benzo(k)fluoranthene were detected in one sample. The concentrations of phenol and 2-methylphenol showed very little variability across locations, with phenol ranging from an estimated 50 µg/kg to an estimated 66 µg/kg and 2-methylphenol ranging from an estimated 4.6 µg/kg to an estimated 6.7 µg/kg. The concentration

of benzoic acid also showed little variability across locations ranging from 1,700 to 6,300 µg/kg, with locations in Dogfish Bay generally being slightly higher than those in the tide flats.

The results of the 2004 shellfish tissue sampling event were similar to the results of the 2009 sampling event. Low levels of phenanthrene and 2-methylphenol and relatively high levels of benzoic acid were detected. However, benzo(b)fluoranthene, benzo(k)fluoranthene, and phenol were not detected in 2004. Benzoic acid and 2-methylphenol were detected in all six tissue samples, and phenanthrene was detected in two samples. Concentrations of 2-methylphenol were higher in 2004 than in 2009. However, concentrations of benzoic acid were generally lower in 2004 than in 2009, with concentrations in the tide flats generally being higher than in Dogfish Bay.

More compounds were detected during the 2000 sampling event compared to the 2009 and 2004 events. However, this may be the result of the lower detection limits achieved in 2000 compared to 2009 and 2004. Low levels of naphthalene, phenanthrene, anthracene, 2-methylnapthalene, fluoranthene, pyrene, dimethyl phthalate, diethyl phthalate, di-n-butyl phthalate, phenol, 2-methylphenol, and benzyl alcohol and high levels of benzoic acid were detected in tissue samples collected in 2000. The most frequently detected compounds included naphthalene, diethyl phthalate, phenol, benzyl alcohol, and benzoic acid. As with the 2009 sampling results, the 2000 sampling results also showed very little spatial variability and the benzoic acid concentrations were generally higher in the Dogfish Bay samples than in the tide flats samples. In addition, concentrations of benzoic acid in 2000 were similar to concentrations in 2009.

The results of the 1996 shellfish tissue sampling event were similar to the results of the 2009 sampling event. Low levels of diethyl phthalate, phenol, and benzyl alcohol and relatively high levels of benzoic acid were detected. However, benzo(b)fluoranthene, benzo(k)fluoranthene, and 2-methylphenol were not detected in 1996. Benzoic acid and diethyl phthalate were detected in all six tissue samples, phenol was detected in three samples, and benzyl alcohol was detected in two samples. Concentrations of benzoic acid were generally lower than in 2009, with no clear spatial trends.

Concentrations of SVOCs in tissue are generally low, except for the benzoic acid concentrations. Based on the four sampling results, the spatial concentration trends for benzoic acid have not been consistent between the sampling rounds. If the landfill were the source of benzoic acid, the concentrations in the tide flats should be consistently higher than in Dogfish Bay. However, during the 2000 and 2009 sampling events, concentrations were lower in the tide flats than in Dogfish Bay, and during the 1996 sampling event, concentrations were generally similar between the two areas. Only during 2004 were the concentrations higher in the tide flats when compared to Dogfish Bay. Furthermore, benzoic acid is commonly found in the marine environment of Puget Sound (U.S. Navy 1993 and PSEP 1991). Based on this, it is unlikely that

the source of these compounds is the landfill, and it is recommended that monitoring for SVOCs in marine tissue be discontinued.

PCBs were not detected in any of the 2004 and 2009 shellfish tissue samples (see Table 6-6). Aroclor 1254 was detected in one marine tissue sample in 2000 at a concentration that exceeds the RG of 15 μg/kg and in two marine tissue samples in 1996, both at concentrations less than the RG. Because there has been no exceedance of the PCB RG over the past 9 years, it is recommended that monitoring for PCBs in marine tissue be discontinued. However, if changes are made to the landfill, such as removal of the asphalt paving, which may change groundwater flow patterns, then monitoring for PCBs in marine tissue should be reconsidered.

One pesticide compound was detected at a low concentration in marine tissue during the 2009 sampling event. The concentration of endosulfan II was an estimated 0.47 μg/kg. During 2004, eight pesticide compounds (alpha-benzene hexachloride [BHC], heptachlor epoxide, gamma-chlordane, endosulfan I, dieldrin, endrin, endosulfan II, and 4,4'-DDT) were detected at low concentrations, ranging from an estimated 0.22 to 5.4 μg/kg. Five pesticide compounds (alpha-BHC, gamma-BHC, 4,4'-DDE, endrin, and 4,4'-DDT) were detected in 2000 at low concentrations, ranging from an estimated 0.4 to 2.1 μg/kg. Finally, one pesticide compound (alpha-BHC) was detected in 1996 at an estimated concentration of 0.3 μg/kg. No RGs were established for these compounds. Based on the low detected concentrations and the sporadic nature of the detections, it is recommended that monitoring for pesticides in marine tissue be discontinued.

All seven of the target metals were detected in marine tissue collected in 2009 at low concentrations (see Table 6-6). The highest concentrations of metals in the 2009 marine tissue samples were detected in TF-20 (beryllium, chromium, lead, mercury, and nickel) and DB-08 (arsenic and zinc). The lowest concentrations were detected in DB-07 (arsenic, beryllium, chromium, lead, mercury, and nickel) and TF-20 (zinc). Concentrations of metals have generally exhibited stable or decreasing concentration trends. However, zinc concentrations increased from a low in 1996 to a high in 2000, with a decreasing trend from the high in 2000. Nickel concentrations showed a similar trend at two locations. Although the chromium and lead concentrations showed an overall decline since monitoring began, the 2009 concentrations at several locations were higher than the 2004 concentrations and, in some cases, were the highest ever detected. The 2009 lead concentration at DB-05, DB-08, and the field duplicate at TF-20 and the 2009 chromium concentration in the field duplicate at TF-20 were the highest ever detected. The 2009 chromium concentrations at DB-05, DB-08, and TF-20 (environmental sample) were higher than the 2004 concentrations, but the 1996 and 2000 concentrations were higher than the 2009 concentrations. There are no RGs for metals in marine tissue.

If the landfill were the source of the metal contaminants in the marine tissue at the site, the concentrations of metals would be expected to decrease with increasing distance from the landfill. The highest concentrations of most metals were detected in TF-20, and not TF-21, which is the closest location to the landfill. Furthermore, concentrations of most metals were higher in DB-05 and DB-08 when compared to TF-18 and TF-21. Because the landfill does not appear to be the source of the elevated metals concentrations and the detected concentrations are low, it is recommended that monitoring for metals in marine tissue be discontinued. However, if chromium concentrations continue to increase in sediment samples collected in the marsh area, then monitoring of metals in marine tissue should be reconsidered.

In summary, it is recommended that monitoring marine tissue for all analytes be discontinued. However, if changes are made to the landfill, such as removal of the asphalt paving, which may change groundwater flow patterns, monitoring for PCBs in marine tissue should be reconsidered. Furthermore, if chromium concentrations continue to increase in sediment samples collected in the marsh area, monitoring of metals in marine tissue should also be reconsidered. These recommended changes to OU 1 monitoring will be considered during overall revisions to the OU 1 LTM plan recommended by this 5-year review (Section 8).

OU 1 Phytoremediation and Tide Gate Monitoring

Groundwater elevation data were collected quarterly throughout this 5-year review period. The groundwater elevation data are similar to those collected since the inception of phytoremediation at OU 1 Area 1. Based on current and previous measurements, overall groundwater flow patterns of the upper aquifer have remained relatively constant since observations first began in the post-remedial investigation in 1996. The data do not reveal any discernable effect from the trees on groundwater flow direction or gradient (U.S. Navy 2009c). Because of the stable conditions of the aquifer, it is recommended that the water level monitoring frequency be reduced to once every 5 years, which is consistent with the ROD requirements.

For the north plantation, the overall groundwater flow direction in 2009 was toward the northwest for the northern portion and to the west-northwest for the southern portion. The upper aquifer groundwater flow direction in the north plantation toward the marsh creek and tide flats is consistent with the historical groundwater flow direction. For the south plantation, the overall groundwater flow direction in 2009 was to the west-southwest in the northern portion and toward the west-northwest in the southern portion (both towards the marsh creek and marsh pond), which is consistent with the historical interpretation of the groundwater flow direction in the upper aquifer. The groundwater flow direction is southwesterly in the far eastern portion of the south plantation, influenced by the flow towards the marsh creek.

In the intermediate aquifer, groundwater flow beneath the south end of the landfill is generally directed northwest to northward, and groundwater flow underlying the north end of the landfill is generally directed westward toward the tide flats. All groundwater in the intermediate aquifer appears to discharge to the tide flats, which prevents groundwater from beneath the landfill from flowing off site to the west.

Periodic sampling and analysis of groundwater and surface water samples is conducted as part of phytoremediation monitoring and other monitoring of OU 1. A discussion of groundwater and surface water sampling, including concentration trends, is provided in the two subsections above ("OU 1 Groundwater Monitoring Data" and "OU 1 Surface Water and Seep Monitoring Data") and that information is not repeated here.

Periodic plantation inspections were conducted eight times per year for this 5-year review period (U.S. Navy 2005b, 2006b, 2007b, 2008b, and 2009c). Trees at both plantations remained healthy throughout the 5-year review period. Soil nutrient analyses conducted in April 2004 showed relatively low nutrient levels and poor organic matter content in the soils at both plantations. To maintain growth of poplar trees, application of fertilizer continued through the review period to address these poor nutrient conditions. Early application of pesticides, which was initiated in 2004 and continued throughout the review period, kept pest infestations to a negligible level, compared to prior years, and physical weeding and herbicide application greatly reduced competition from weeds. In addition, infested alder trees and blackberry bushes adjacent to the south plantation were removed in 2004 to minimize the likelihood of future infestations. Early pruning was implemented as needed based on site conditions to reduce the occurrence of leaf rust.

The trees exhibited some water stress during the summers of 2004, 2005, and 2006, but this stress was relieved through periodic use of the irrigation system. Because of a wetter summer in 2007 and more proactive watering of the trees in 2007 and 2008, no water stress was observed during these 2 years. The trees weathered strong windstorms during the fall and winter seasons throughout the 5-year review period, with no substantial limb or trunk breakage and no toppling or uprooting of trees. However, small lower branches broke away from several trees (approximately 20) at the trunks during the December 2008 and January 2009 snowfall events. Growth throughout the 5-year period was not directly measured, but appeared to be in the range of the modest growth expected, considering the poor soils at the site. The closed leaf canopy was maintained, maximizing the functionality of the plantations to draw water. Furthermore, no trees were lost during this 5-year review period, although one pest-infested tree was removed from the north plantation during August of 2004.

During this 5-year review period, tide gate inspection and maintenance events were conducted on a quarterly basis. The purpose of the inspection is to document that the tide gate is working as intended. During high-tide events, water on the landfill side of the culvert was maintained at a

relatively constant level during all inspections conducted during the 5-year review period. Other routine maintenance activities conducted included manually removing organic debris and marine organisms from various surfaces and moving parts of the tide gate. No major tide gate maintenance was required in 2006 and 2008. One back float was found to be missing in October 2004. As a result, in 2004 and early 2005, both back floats were replaced. In addition, a broken float bracket was replaced in May 2007.

As described above, it is recommended that water level monitoring frequency be reduced to once every 5 years. This recommended change to OU 1 monitoring will be considered during overall revisions to the OU 1 LTM plan recommended by this 5-year review (Section 8).

6.4.2 OU 2 Area 2 Monitoring Data

At Area 2, groundwater concentration trends for the COCs TCE and vinyl chloride, as well as for the related compound cis-1,2-DCE, have been tracked since the ROD was signed (U.S. Navy 2009f). Historical and recent groundwater monitoring data for Area 2 are summarized in Tables 6-7 and 6-8. Sampling locations are shown on Figure 4-3.

Overall, concentrations of COCs continue to decrease, and concentrations detected at the site in the spring of 2009 met the RGs for TCE at two of the groundwater monitoring wells and for vinyl chloride at all three of the wells (see Table 6-7). At well 2MW-1, which is located within the source area, the TCE concentration continues to demonstrate an overall decline. However, the TCE concentration detected in spring 2009 was slightly higher than the concentration detected in the spring of 2008. In addition, the 2009 concentration of TCE in this well slightly exceeded the RG. At well 2MW-6, which is located downgradient of the site, vinyl chloride and cis-1,2-DCE also exhibited a general decline. However, results for these two compounds increased slightly from spring 2008 to spring 2009. Vinyl chloride concentrations have met the RG for the last 3 years, since spring of 2007. Cis-1,2-DCE concentrations have never exceeded the RG in well 2MW-6. Occurrence of the TCE breakdown products vinyl chloride and cis-1,2-DCE at this downgradient monitoring well location (2MW-6) together with the absence of TCE at that location indicates that degradation of TCE is occurring beneath the site.

Only one target VOC (cis-1,2-DCE) has been consistently detected at well MW2-8, and detected concentrations have been at very low (trace) concentrations. The concentration of cis-1,2-DCE at well MW2-8 in 2009 was similar to the concentrations measured in 2008 and several previous sampling and testing events. Vinyl chloride has been detected randomly at very low (trace) concentrations at this well. TCE has not been detected in excess of its method reporting limit in well MW2-8 during any of the sampling and testing events from 2001 through 2008. The results from well MW2-8 imply that the VOC plume is relatively stable in this area.

At the request of Ecology, the Navy also analyzed groundwater samples from the three monitoring wells for 1,4-dioxane as a one-time sampling event in spring 2007 (see Table 6-8). 1,4-dioxane was only detected in one well (2MW-6) at an estimated concentration of 0.3 µg/L. There is no RG established for 1,4-dioxane. However, the current MTCA Method B cleanup level is 4 µg/L (see Section 7.2.1).

Because concentration trends of COCs have either been stable or declining in all site wells, it is recommended that monitoring be decreased to once every 2 years. This is consistent with the ROD, which states that monitoring frequencies can be reduced if concentrations decrease with time. These recommended changes to OU 2 Area 2 monitoring will be considered during overall revisions to the OU 2 LTM plan recommended by this 5-year review (Section 8).

6.4.3 OU 2 Area 8 Monitoring Data

Historical and recent monitoring data for Area 8 are summarized in Tables 6-9 through 6-13. Sampling locations are shown on Figure 4-4. Trends in the data observed over the last 5 years are summarized by medium in the sections that follow.

OU 2 Area 8 Groundwater Monitoring Data

At Area 8, groundwater concentration trends for seven target analytes (TCE, 1,1,1-TCA, tetrachloroethene [PCE], 1,1-DCE, cis-1,2-DCE, dissolved cadmium, and dissolved chromium) have been tracked since signing of the ROD (U.S. Navy 2009d). Historical and recent groundwater monitoring data for Area 8 are summarized in Tables 6-9 through 6-11. Sampling locations are shown on Figure 4-4.

Overall, the VOC trends are toward lower concentrations, with the exception of the deeper well MW8-16. Although concentrations have generally declined, the concentration of TCE still exceeds the RG at five of the six wells being monitored at the site, and the concentration of PCE exceeds the RG at two of the wells (see Table 6-9). RGs are not expected to be met for TCE and PCE in groundwater in the foreseeable future.

At MW8-8, the PCE and 1,1,1-TCA concentrations have declined since the last 5-year review, and TCE concentrations continued to decline at a slow rate. One daughter product of degradation, cis-1,2-DCE (daughter product of TCE), exhibited a slightly increasing trend at MW8-8. However, concentrations of this compound are much lower than the RG. At well MW8-9, the TCE and cis-1,2-DCE concentrations have continued their overall decline. However, the TCE concentration increased in spring 2009 to a level exceeding the RG after having remained below the RG for four consecutive sampling events from 2005 through 2008. All other VOCs at well MW8-9 have continued to meet their RGs. At well MW8-11, 1,1-DCE and 1,1,1-TCA concentrations have declined since the last 5-year review, while TCE

concentrations exhibited a stable overall trend. At well MW8-12, PCE and TCE concentrations have exhibited a slightly decreasing trend since the last 5-year review. All other VOCs at well MW8-12 have continued to meet their RGs. At MW8-16, TCE concentrations continued an overall increasing trend since the last 5-year review. However, cis-1,2-DCE concentrations appear to be declining relative to the high in 2004. Concentrations of target VOCs in well MW8-14 were not detected or were detected at low concentrations. Although concentrations of target VOCs in well MW8-14 have been either not detected or detected at low concentrations, it is recommended that VOC monitoring of this well be continued to support tracking of potential vertical migration.

At the request of Ecology, the Navy also analyzed groundwater samples from the six monitoring wells for 1,4-dioxane as a one-time sampling event in spring 2007 (see Table 6-10). 1,4-Dioxane was detected in three of the six wells (MW8-8, MW8-11, and MW8-12) at concentrations ranging from an estimated 0.7 to 39 µg/L. There is no RG established for 1,4-dioxane. However, the current MTCA Method B cleanup level is 4 µg/L (see Section 7.2.1), which was exceeded in well MW8-11.

Overall, the metals trends are toward lower concentrations. Although concentrations have generally declined, the concentration of the target analytes, dissolved cadmium and dissolved chromium, still exceed their respective RGs at one or more wells being monitored at the site. In 2009, dissolved cadmium and dissolved chromium exceeded their respective RGs at two of the six wells being monitored. In addition, groundwater samples from one or more wells have continued to exhibit concentrations exceeding the RGs for arsenic, copper, nickel, silver, and zinc over the last 5 years. RGs are not expected to be met for metals in groundwater in the foreseeable future.

At well MW8-8, the dissolved chromium concentrations continued a slow overall decline to a value less than the RG in 2009, while the dissolved cadmium concentration remained stable at a level below the drinking water RG. At well MW8-9, the dissolved chromium concentrations continued a slow overall decline, while the dissolved cadmium concentration remained stable. Both dissolved cadmium and chromium concentrations remain under their respective RGs at this well. At wells MW8-11 and MW8-12, dissolved cadmium and chromium concentrations continued an overall decline. At well MW8-14, dissolved cadmium and chromium exhibited generally steady concentrations. Target metals at well MW8-16 were not detected or were detected at only low concentrations. Although target metals in well MW8-16 have been either not detected or detected at low concentrations, it is recommended that metals monitoring at this well be continued to support tracking of potential vertical migration.

In summary, no change is recommended to the groundwater monitoring plan for Area 8.

OU 2 Area 8 Seep Monitoring Data

At Area 8, seep concentration trends for seven target analytes (TCE, 1,1,1-TCA, PCE, 1,1-DCE, cis-1,2-DCE, dissolved cadmium, and dissolved chromium) have been tracked since the signing of the ROD (U.S. Navy 2009d). Historical and recent seep monitoring data for Area 8 are summarized in Tables 6-9 and 6-11. Sampling locations are shown on Figure 4-4.

Overall, VOC concentrations in Seep A (Table 6-9) have either exhibited stable or slightly increasing trends over the past 5 years, although concentrations remain well below the spike observed in 2004. VOCs in Seep B have either been not detected or detected at very low levels. The surface water RGs have not been exceeded at either of the seeps in the last 5 years. However, TCE was detected above the drinking water RG in samples collected from Seep A in 2008 and 2009. Based on these results, it is recommended that monitoring of VOCs be discontinued at Seep B.

Overall, dissolved cadmium and dissolved chromium concentrations in Seeps A and B have either exhibited stable or decreasing trends over the past 5 years. In addition, none of the target metals exceeded their surface water RGs in seep samples collected in 2008 and 2009, with the exception of arsenic, whose concentrations were lower than background levels. At Seep A, dissolved cadmium concentrations have exhibited a strongly decreasing trend over the last 5 years, with the 2009 concentration more than an order of magnitude lower than the high detected in 2004. Dissolved chromium concentrations at Seep A have varied over the last 5 years, but remain significantly lower than the high detected in 2004. However, dissolved cadmium concentrations exceeded the surface water RGs in Seep A in 2005, 2006, and 2007. At Seep B, the dissolved cadmium and chromium concentrations have exhibited a steady decrease over the last 5 years. In addition, none of the target metals have exceeded their surface water RGs in Seep B since 2004, with the exception of arsenic. However, arsenic concentrations were below the groundwater background concentration (12 µg/L). Based on these results, it is recommended that monitoring of metals be discontinued at Seep B.

In summary, it is recommended that monitoring Seep B for VOCs and metals be discontinued. This recommended change to OU 2 Area 8 monitoring will be considered during overall revisions to the OU 2 Area 8 LTM plan recommended by this 5-year review (Section 8). The Navy has agreed to prepare a sampling and analysis plan to further investigate chemical concentrations in the vicinity of Seeps A and B. This investigation will focus on the intertidal area but will extend into deeper sediments if warranted.

OU 2 Area 8 Sediment Monitoring Data

Sediment sampling is conducted at the time of each 5-year review, and data are now available from 1996 (the post-ROD sampling event), 2000, 2004, and 2008 (Table 6-12). Bioassays were

also performed in 2008 and are discussed in Section 7.3.2. Samples are collected from nine stations along three transects on the beach bordering Liberty Bay (Figure 4-4) and analyzed for SVOCs and metals (U.S. Navy 2009e).

When comparing the 2008 results of SVOCs in sediment with the 1996, 2000, and 2004 results, the 2008 phenol concentrations are generally lower at most stations except Stations 4 and 6. The mean concentration of all stations has declined from 1,294 µg/kg in 1996 to 341 µg/kg in 2008. The reason for the overall decrease in phenol concentrations at the sediment stations is unclear, but could be caused by degradation of an unknown off-site phenol source. In spite of the declining concentration trend, phenol continued to exceed the SQS at four stations (1, 4, 6, and 8) during the 2008 sampling event. Fluoranthene was undetected in all but two samples during the 2008 sampling event. In addition, phenanthrene was undetected in one sample and detected at very low concentrations in the remaining samples during 2008. The mean concentration of all stations for these two compounds also has declined from 1996 through 2008. All detected concentrations of these two compounds are well below the SQSs.

Based on these sampling results, the 2008 sediment and tissue LTM report recommended that further LTM of SVOCs in sediment be discontinued for the following reasons:

- Groundwater is not the source of SVOCs in sediment at Area 8.
- Concentrations of SVOCs, with the exception of phenol, are very low.
- The mean concentration of phenol in all stations at the site has steadily declined since monitoring began in 1996, and the mean concentration is currently lower than the SQS.

Cadmium was the only metal that exceeded the SQS during the 2008 sampling event. Cadmium exceeded the SQS (5.1 mg/kg dry weight) at Stations 3, 5, 6, 8, and 9 (see Figure 4-4 and Table 6-12). The cadmium concentrations at these stations were an estimated 13.8, 10.2, 7.3, 15, and 21.9 mg/kg, respectively. In general, these concentrations are the highest concentrations detected in the sediment since testing began in 1996. Cadmium concentrations appear to be increasing or slightly increasing at eight of the nine stations. Only at Station 4 do the concentrations appear to be decreasing. The mean site cadmium concentrations increased from 2.4 mg/kg in 1996 to 8.1 mg/kg in 2008.

Mercury concentrations appear to be decreasing or slightly decreasing at five of the nine stations (Stations 1, 2, 4, 7, and 8) and increasing at the remaining stations. The mean site mercury concentrations also appear to be decreasing from 0.28 mg/kg in 1996 to 0.097 in 2008. The mean concentrations for copper, lead, nickel, silver, and zinc appear to be generally increasing from 1996 to 2008. However, the increases are all significantly less than an order of magnitude,

and concentrations are well below their respective SQS. The mean chromium concentrations continue to decline at the site.

Based on these sampling results, the 2008 sediment and tissue LTM report recommended that LTM of metals in sediment be continued at Stations 2, 3, 5, 6, 8, and 9 and discontinued at Stations 1, 4, and 7. Cadmium and mercury concentrations in sediment at Stations 1, 4, and 7 have not exceeded their respective SQS since monitoring began in 1996.

In summary, the 2008 LTM report recommended that monitoring sediment for SVOCs at all stations be discontinued and that monitoring for metals at Stations 1, 4, and 7 be discontinued, which would result in no further monitoring of Stations 1, 4, and 7. These recommended changes to OU 2 Area 8 monitoring will be considered during overall revisions to the OU 2 Area 8 LTM plan recommended by this 5-year review (Section 8).

OU 2 Area 8 Shellfish Tissue Monitoring Data

As with sediment sampling, shellfish sampling is conducted at the time of each 5-year review, and data are now available from 1996 (the post-ROD sampling event), 2000, 2004, and 2008 (Table 6-13). Shellfish samples are collected along the same beach transects and at the same sampling locations used for sediment sampling (U.S. Navy 2009e).

The average 2008 concentrations for the SVOCs fluoranthene and pyrene are less than the average 1996, 2000, and 2004 concentrations. An evaluation of phenol trends is not possible because only one marine tissue sample was analyzed in 1996, detection limits in 2000 and 2004 were generally lower than the detection limits achieved in 2008, and the compound was not detected in 2004 and 2008 at any of the shellfish tissue monitoring stations. The average 2008 concentration for benzoic acid is less than the average 2000 and 2004 concentrations. However, the average 2008 concentration for benzoic acid is greater than the average 1996 concentration. Although the detected concentrations of fluoranthene, pyrene, and benzoic acid exhibited some variability across the nine tissue stations, the variability was less than an order of magnitude, and no clear spatial trend is apparent based on the 2008 data.

Based on these sampling results, the 2008 sediment and tissue LTM report recommended that further LTM of SVOCs in marine tissue be discontinued for the following reasons:

- Groundwater is not the source of SVOCs in marine tissue at Area 8.
- Phenol has not been detected in marine tissue during the past two sampling rounds.

- The mean concentration of SVOCs in marine tissue for all stations at the site has generally declined since monitoring began in 1996.

The average 2008 concentrations for the eight target metals are less than the average 1996 and 2004 concentrations. However, the average 2008 concentrations for cadmium, lead, mercury, and silver are greater than the average 2000 concentrations. For these four chemicals, the lowest average concentrations in marine tissue occurred in 2000. For the remaining metals (chromium, copper, nickel, and zinc), the lowest average concentrations in marine tissue occurred in 2008. As with the SVOC data, no specific spatial distribution pattern was discernible for the detected metals in tissue samples. Based on the sediment and marine tissue sampling results, the 2008 sediment and tissue LTM report recommended that LTM of metals in marine tissue be continued at Stations 2, 3, 5, 6, 8, and 9 and discontinued at Stations 1, 4, and 7.

In summary, the 2008 LTM report recommended that monitoring marine tissue for SVOCs at all stations be discontinued and that monitoring marine tissue for metals at Stations 1, 4, and 7 be discontinued, which would result in no further monitoring of marine tissue at Stations 1, 4, and 7. These recommended changes to OU 2 Area 8 monitoring will be considered during overall revisions to the OU 2 Area 8 LTM plan recommended by this 5-year review (Section 8). Risks to human health and the environment posed by the detected concentrations of metals and SVOCs in shellfish tissue are discussed in Section 7.

6.4.4 Institutional Controls Inspection Data

The findings of the June 2009 institutional controls inspection are summarized below. These findings are consistent with those from 2005 through 2008.

For OU 1 Area 1, the former landfill, the inspection found the following:

- The area is being used as a parking lot and motorcycle training course. There are also two phytoremediation plantations at the site.

- Security procedures for base entry have maintained restricted access to Keyport.

- No new water well has been installed in the last year in Area A (between the marsh and tide flats), Area B (between the tide flats and Pass and ID building), or Area D (the former landfill), nor on Navy property within 1,000 feet of the former landfill. Wells previously have been installed in these areas for monitoring and remedial action purposes.

- No activity has occurred in Area C—the tide flats—that could interfere with or compromise monitoring or remedial actions.

- No employee is permanently assigned to work in buildings in Area D, the former landfill.
- The only land use activities for Area D—the former landfill—are those involving occasional occupancy by workers.
- Keyport follows an excavation/dig permit procedure to control construction and digging activities at Area D, the former landfill. The permit requirements have been effective in maintaining the requirements of the institutional controls plan.
- No activity occurred in Area E—the marsh pond or marsh system—that has disturbed the wetlands, resulted in an exposure hazard, interfered with or compromised the monitoring, or interfered with or compromised remedial actions for the landfill.

For OU 2 Area 2, Van Meter Road Spill/Drum Storage Area, the inspection found the following:

- The area is being used for reutilization of government equipment, which is classified as light industrial use.
- Security procedures for base entry have maintained restricted access to Keyport.
- Construction and digging activities have been controlled by the base excavation/dig permit procedure and have been effective in maintaining the requirements of the institutional controls plan.
- No water wells have been installed at OU 2 Area 2, except those installed previously for monitoring or remedial actions.
- No residential development has occurred at OU 2 Area 2.

For OU 2 Area 8, Plating Shop Waste/Oil Spill Area, the inspection found the following:

- The area is being used for light industrial use and as a parking lot.
- Security procedures for base entry have maintained a restricted access.
- Construction and digging activities have been controlled by the base excavation/dig permit procedure and have been effective in maintaining the requirements of the institutional controls plan.

- No water wells have been installed at OU 2 Area 8, except those installed previously for monitoring or remedial actions.

- No residential development has occurred at OU 2 Area 8.

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 was performed 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 included verifying that remedial actions remained operational (for those items that could be visually inspected) and inspecting all portions of the site covered by institutional controls.

Site conditions observed at OU 1, OU 2 Areas 2 and 8, and Site 23 indicate that institutional controls requirements for these sites are being met. Institutional controls inspections are being performed and documented yearly, and documentation is available. An asphalt patch was observed at OU 2 Area 8, implying that excavation had been performed for utility work. Interviews by NAVFAC NW of NBK personnel indicate that a dig permit was obtained prior to this excavation work being performed, in compliance with the institutional controls.

The paved portion of the OU 1 former landfill was visually inspected, as were the stormwater control facilities. The paving and stormwater facilities appeared to be in good condition overall. Substantial vegetation has grown in the vicinity of the western stormwater discharge. However, the vegetation does not appear to be impeding flow or causing ponding on the landfill surface.

The phytoremediation plantations at OU 1 were in good health. On-site documentation, including O&M and health and safety plans, are out of date. Current documentation is retained at the NAVFAC NW office. Following the site inspection, the Navy remedial project manager removed the out-of-date documents from the site.

The tide gate at OU 1 was functioning and in good condition. Documentation is available of regular tide gate inspections and maintenance.

6.6 RESULTS OF INTERVIEWS

Interviews were conducted with persons familiar with the CERCLA actions at NBK Keyport. Interviewees were selected from the Navy (including NAVFAC NW and NBK Keyport), EPA, Ecology, Kitsap County Health, the Suquamish Tribe, 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 by 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

Navy personnel associated directly with NBK Keyport and personnel from NAVFAC NW were interviewed.

NBK Keyport

The respondent from NBK Keyport was not aware of any O&M issues with the remedies and did not believe that any additional actions were warranted. The respondent's understanding was that the phytoremediation plantations were not showing the expected effectiveness, but that the natural attenuation results were acceptable. The respondent was not aware of any institutional control violations or community concerns. Her belief was that the community was satisfied with the Navy's actions and that community interest has waned. The respondent recommended that the community be kept informed through a community newsletter that conveyed the ongoing monitoring results.

NAVFAC NW Personnel

The NAVFAC NW respondent felt that the remedy components were generally functioning well and was not aware of any institutional control violations. Institutional controls are inspected annually, with a report to Ecology and EPA each September.

OU 1. Phytoremediation is providing some degree of remediation of VOCs in groundwater beneath OU 1, although aquifer conditions appear to prevent the trees from achieving the expected changes in groundwater elevation. The lack of PCB detections in clam tissue over time demonstrates that the PCB-contaminated sediment removal was effective. The tide gate has remained effective at preventing erosion and the upgraded landfill cover has prevented exposure to landfill contents. LTM has been effective and demonstrates that contingent actions are not necessary. Intrinsic bioremediation is very effective at reducing the high VOC concentrations in the source areas to much lower concentrations where groundwater discharges to surface water. No institutional control violation has occurred, and there has been no significant operation or maintenance difficulty with the remedy.

Monitoring at OU 1 exceeds the ROD requirements and can be scaled back.

OU 2. The respondent has reviewed excavation projects at Area 2, in accordance with the institutional control requirements. The Area 2 groundwater contaminant concentrations are close to the RGs. Soil excavation and disposal, and subsequent paving, at Area 8 removed the potential for contact with contaminated soil. Institutional controls have been effective at Area 8. Bioassay testing shows that the site poses no ecological risk. In combination with the monitoring data and human health risk assessment, the bioassay results indicate that additional groundwater control actions are not necessary. OU 2 monitoring has met the ROD requirements.

6.6.2 Agency Personnel

Ecology responded with concurrence on the Navy statement, "Phytoremediation is probably having some degree of positive effect on contaminant reduction. At the least, the phytoremediation process does not appear to be impeding or having a negative effect on the naturally occurring biodegradation process at OU 1." However, Ecology believes that phytoremediation is not effective for contaminants in the intermediate aquifer. Ecology also believes that intrinsic bioremediation is not effective in controlling the off-site migration of VOCs in the intermediate aquifer. Ecology responded that the sediment removal action was not effective with regard to Seep SP1-1 meeting the RG. All other OU 1 remedy components are working as intended or designed.

Ecology stated that the excavation and off-site disposal of contaminated soil from OU 2 Area 8 has not been effective in preventing the migration of contaminants to Liberty Bay and believes that the groundwater results are indicative of a residual source at the site. Based on a draft Agency for Toxic Substances and Disease Registry health consultation from September 2009, Ecology believes that further investigation and control actions are warranted at Area 8.

Ecology responded that the agency had regularly received reports from the Navy and that the institutional controls are working as intended or designed. Ecology has received no complaints or notices of violations regarding the site and was not aware of any community concerns. Ecology believes that monitoring is sufficient at OU 1 and insufficient at OU 2 Area 8.

The Kitsap County Health District expressed concern that their agency did not have information regarding the remedies at NBK Keyport and therefore could not comment specifically.

6.6.3 Community

The Suquamish Tribe responded that, overall, the remedies at OU 1 and OU 2 Area 8 have not effectively addressed the contamination. The Tribe recommended that an estimate of restoration time frame be made. The Tribe also cited the Memorandum of Agreement between the

Department of Defense and the Suquamish Tribe and called for more active involvement by the Tribe in remediation and site management decisions.

The Tribe's opinion is that the LTM data at OU 1 provide no evidence that phytoremediation has been effective, noting that regulatory criteria for protection of surface water, and the ROD RGs, continue to be exceeded. Biodegradation alone does not appear to be sufficient to meet the RGs. Based on the data from Seep SP1-1, the PCB-contaminated sediment removal has not been effective at eliminating PCB discharge to the aquatic environment. Other OU 1 remedy components appear to be functioning as intended.

The Tribal respondent noted that Area 2 groundwater contaminant levels have decreased and generally meet the RGs. At Area 8, however, the Tribe feels that excavation of vadose-zone soils has not been effective and that the remedy is not protective of either human health or the environment. The Tribe believes that further investigation and evaluation is warranted at Area 8 and that additional groundwater control actions and possibly sediment remediation are warranted. Risk assessment work conducted at Area 8 has not addressed the concerns of the Suquamish Tribe.

The Tribe reported being given the opportunity to comment on reports, but that communication regarding resolution of comments and scheduling is limited.

The Tribal respondent noted that the presence of contamination impacts protected resources and limits the Tribe's ability to safely gather and consume fish and shellfish from the area.

One community member responded and indicated that she believed that the remedy was working "except for the copper plating"—presumably referring to the former plating shop at OU 2 Area 8. The respondent was happy with the way the remediation was conducted and requested that the community be kept informed.

Table 6-1
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
RG (Drinking Water)		800	5	0.5	70	100	5	200	5	0.50
RG (Surface Water)			59	1.9		33,000	4.2	41,700	56	2.9
1MW-1	08/25/95	14	1 U	**5.1**	**590 J**	**180 J**	1 U	1 U	1 U	**1000 J**
	12/06/95	1	1 U	**1 U**	**87 J**	7.7	1 U	1 U	1 U	**210 J**
	03/12/96	8.5	0.5 U	**2.6**	**450 J**	**120 J**	0.5 U	0.5 U	0.62	**710 J**
	06/26/96	15	0.5 U	**3.2**	**460 J**	**220 J**	0.5 U	0.5 U	.51 U	**1200 J**
	06/11/99	19	3 U	**4**	**310**	**170**	3 U	3 U	3 U	**960**
	10/20/99	17	0.5 U	**2.9**	**320**	**190**	0.5 U	0.5 U	0.5 U	**970**
	04/25/00	18	0.5 U	**3.1**	**380 J**	**210 J**	0.5 U	0.5 U	0.5 U	**1200 J**
	06/07/00	13	0.5 U	**1.7**	**240 J**	**210 J**	0.5 U	0.5 U	0.58	**1200 J**
	07/24/00	25 U	**25 U**	**25 U**	**280 J**	**170 J**	**25 U**	25 U	**25 U**	**920 J**
	10/31/00	17	1 U	**2**	**270**	**160**	1 U	1 U	1 U	**1300**
	04/27/01	17	1 UJ	**3.9**	**250 J**	**170 J**	1 U	1 UJ	0.6 J	**770 J**
	06/20/01	19	0.58 U	**2.5 J**	**240**	**170**	0.55 U	0.56 U	0.59 U	**860**
	07/30/01	14 J	1 U	**2.4**	**240 J**	**170**	1 U	1 U	1 U	**1500 J**
	10/29/01	14 J	1 U	**1.5**	**160 J**	**130**	1 U	1 U	1 U	**970 J**
	04/30/02	16 J	2.5 U	**2.6 J**	**280 J**	**180 J**	2.5 U	2.5 U	2.5 U	**750 J**
	06/19/02	12 D	2.5 U	**1.7 JD**	**170 D**	**130 D**	2.5 U	2.5 U	2.5 U	**970 D**
	07/23/02	15 J	2.5 U	**2.6 J**	**280 J**	**200 J**	2.5 U	2.5 U	2.5 U	**1100 J**
	10/24/02	15 J	2 U	**2 U**	**180 J**	**130 J**	2 U	2 U	2 U	**570 J**
	04/29/03	10 D	1.0 U	**1.4 D**	**160 D**	94 D	1.0 U	1.0 U	1.0 U	**780 D**
	10/14/03	14	2.5 U	**1.4 J**	**140**	**140**	2.5 U	2.5 U	2.5 U	**840**
	04/22/04	12	0.5 U	**1.9**	**150 D**	**130 D**	0.5 U	0.5 U	0.31 J	**750 D**
	10/13/04	15	0.12 U	**1.2**	**130 J**	**140 J**	0.11 U	0.12 U	0.23 J	**900 J**
	04/14/05	0.4	0.2 U	0.2 U	0.4	0.6	0.2 U	0.2 U	0.2 U	**4.8**
	10/13/05	13	0.2 U	**0.9**	**100**	91	0.2 U	0.2 U	0.2 U	**830**
	07/10/06	11 DJ	2.5 UJ	**1.1 DJ**	**72 DJ**	**100 DJ**	2.5 UJ	2.5 UJ	2 JD	**820 DJ**
	10/16/06	12	0.5 U	**0.52**	56	92 D	0.5 U	0.5 U	0.14 J	**660 D**
	06/13/07	11	0.5 U	**0.68**	66 D	84 D	0.5 U	0.5 U	0.18 J	**600 D**
	10/18/07	13	0.5 U	**0.63**	69	86 D	0.5 U	0.5 U	0.15 J	**540 D**
	05/13/08	10 D	1.0 U	0.46 D	33 D	67 D	1 U	1 U	0.16 JD	**580 D**
	10/28/08	10 D	1.0 U	0.46 JD	39 D	71 D	1 U	1 U	1 U	**490 D**
	06/18/09	9.6 D	1 U	0.46 D	43 D	73 D	1 U	1 U	1 U	**570 D**
MW1-2	08/28/95	1 U	1 U	**4.2**	**1400 J**	23	1 U	1 U	**36 J**	**150 J**
	12/06/95	1 U	1 U	**3.5**	**1300 J**	22	1 U	1 U	**35 J**	**140 J**
	03/11/96	0.5 U	0.5 U	**4.8**	**1800 J**	30 J	0.5 U	0.5 U	**41**	**200 J**
	06/25/96	0.23 J	0.5 U	**5.1 J**	**1500 J**	31 J	0.5 U	0.5 U	**43 J**	**180 J**
	06/11/99	3 U	3 U	**5**	**980**	26	3 U	3 U	**27**	**160**
	10/20/99	0.5 U	0.5 U	**3.4**	**1000**	21	0.5 U	0.5 U	**23**	**110**
	04/25/00	0.5 U	0.5 U	**6**	**1900 J**	49 J	0.5 U	0.5 U	**13**	**230 J**
	06/08/00	0.30 J	0.20 J	**3.2 J**	**890 J**	21 J	0.5 U	0.5 U	**22 J**	**110 J**
	07/24/00	25 U	**25 U**	**25 U**	**750 J**	25 U	**25 U**	25 U	**25 U**	**87 J**
	10/31/00	1 U	1 U	**2.2**	**810**	15	1 U	1 U	**12**	**85**
	04/26/01	1 U	1 UJ	**6.3**	**1200 J**	44	1 U	1 UJ	**21**	**120 J**
	06/20/01	0.91 U	1.2 U	**3.6 J**	**950**	18	1.1 U	1.2 U	**19**	**89**
	07/30/01	1 U	1 U	**2.1**	**660 J**	43 J	1 U	1 U	**19**	**130 J**

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MW1-2 (cont.)	10/29/01	1 U	1 U	**2.4**	**700 J**	18	1 U	1 U	**14**	**93**
	04/30/02	2.5 U	2.5 U	**3.6 J**	**1200 J**	29 J	2.5 U	2.5 U	**5 J**	**140 J**
	06/19/02	0.26 J	1.0 U	**2.2 D**	**660 D**	13 D	1.0 U	1.0 U	**15 D**	**75 D**
	07/23/02	1 U	1 U	**2.6 J**	**720 J**	16 J	1 U	1 U	**17 J**	**100 J**
	10/24/02	2.5 U	2.5 U	**2.7 J**	**910 J**	17 J	2.5 U	2.5 U	**21 J**	**120 J**
	04/30/03	2.0 U	2.0 U	**3.4 D**	**870 D**	18 D	2.0 U	2.0 U	**13 D**	**130 D**
	10/15/03	0.26 J	0.5 U	**2.6**	**710**	15	0.5 U	0.5 U	**19**	**120**
	04/22/04	0.37 J	0.5 U	**3.9**	**1200 D**	22	0.5 U	0.5 U	**14**	**200 D**
	10/13/04	0.45 J	0.12 U	**3.6**	**930 J**	23	0.11 U	0.12 U	**6.6**	**160 J**
	04/12/05	0.3	0.2 U	**2.2**	**690**	15	0.2 U	0.2 U	**13**	**180**
	10/12/05	0.4	0.2 U	**2.9**	**810**	20	0.2 U	0.2 U	4.1	**140**
	07/10/06	2.5 U	2.5 U	**2.8 D**	**660 D**	17 D	2.5 U	2.5 U	2 JD	**150 D**
	10/16/06	0.33 J	0.5 U	**2**	**560 D**	16	0.5 U	0.5 U	1.3	**110 D**
	06/13/07	0.36 JD	1 U	**2.1 D**	**680 D**	16 D	1 U	1 U	**5.2 D**	**140 D**
	10/18/07	0.28 JD	1 U	**1.9 D**	**590 D**	15 D	1 U	1 U	**9.5 D**	**98 D**
	05/08/08	0.28 J	0.5 U	**1.8**	**460 D**	13	0.5 U	0.5 U	**7.5**	**110 D**
	10/28/08	0.25 JD	1.3 U	**1.8 D**	**420 D**	11 D	1.3 U	1.3 U	**9.1 D**	**88 D**
	06/19/09	0.22 JD	1 U	**1.5 D**	**460 D**	11 D	1 U	1 U	**6.4 D**	**87 D**
MW1-3	03/08/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/21/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	09/11/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/21/99	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/20/99	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.7	**0.5 U**
	04/25/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	07/24/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/31/00	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	04/27/01	1 U	1 UJ	**1 U**	1 U	1 U	1 U	1 UJ	1 U	**1 U**
	07/30/01	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	10/29/01	1 U	1 U	**1 U**	1	1.1	1 U	1 U	1 U	**3.3**
	04/30/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	07/23/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/24/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/29/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/14/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/21/04	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/13/04	0.091 U	0.12 U	0.12 U	0.12 U	0.15 U	0.11 U	0.12 U	0.12 U	0.23 J
	04/12/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	10/12/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/16/06	0.5 U	0.5 U	0.3 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U	0.09 J
	06/13/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/19/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	05/07/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/28/08	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/19/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MW1-4	08/23/95	1 U	1 U	**7.7**	**6400 J**	80 J	2.2	1 U	**11000 J**	**2000 J**
	12/05/95	1 U	1 U	**5.2**	**3900 J**	**500 U**	1.7	1 U	**8600 J**	**2800 J**
	03/05/96	.67 J	0.5 UJ	**5.6 J**	**3500 J**	56 J	.96 J	0.5 UJ	**6300 J**	**1100 J**
	06/20/96	0.64	0.5 U	**13**	**5900 J**	41	4	0.5 U	**22000 J**	**970 J**
	06/14/99	2 J	3 U	**24**	**12000**	**140**	4	3 U	**2600 E**	**1500**
	10/21/99	0.8	0.5 U	**10**	**5300**	70	0.7	0.5 U	**3600**	**1100**
	04/26/00	1.4	0.5 U	**16**	**8500 J**	**250 U**	**250 U**	**250 U**	**18000 J**	**860 J**
	06/13/00	250 U	**250 U**	**250 U**	**15000 J**	**100 J**	**250 U**	**250 U**	**38000**	**1300**
	07/25/00	250 U	**250 U**	**250 U**	**8500 J**	**250 U**	**250 U**	**250 U**	**18000 J**	**860 J**
	11/09/00	1 U	1 U	**0.9 J**	**660**	12	1 U	1 U	**490**	**190**
	04/27/01	1 U	1 UJ	**6.6**	**3700 J**	74 J	0.8 J	1 UJ	**3900 J**	**700 J**
	06/20/01	4.6 U	**5.7 U**	**18 J**	**12000**	**110**	**5.5 U**	5.6 U	**13000**	**1700**
	07/31/01	1 U	1 U	**2.9**	**2200 J**	95 J	0.6 J	1 U	**2700 J**	**400 J**
	10/30/01	1 U	1 U	**0.5 J**	**270 J**	3	1 U	1 U	**170**	**49**
	05/01/02	2.5 U	2.5 U	**2.5 U**	**600 J**	3.7 J	2.5 U	2.5 U	**730 J**	**54 J**
	06/17/02	50 U	**50 U**	**30 J**	**15000 D**	**100 D**	**50 U**	50 U	**42000 D**	**970 D**
	07/25/02	1 U	1 U	**1.1 J**	**600 J**	2.7 J	1 U	1 U	**580 J**	**95 J**
	10/25/02	0.5 U	0.5 U	**0.8**	**430 J**	3.9	0.5 U	0.5 U	**490 J**	**36 J**
	04/29/03	25 U	**25 U**	**25 U**	**7000 D**	53 D	**25 U**	25 U	**11000 D**	**1100 D**
	10/15/03	13 U	**13 U**	**9.0 J**	**4000**	50	**13 U**	13 U	**2500**	**1800**
	04/21/04	50 U	**50 U**	**18 J**	**8100 D**	71 D	**50 U**	50 U	**20000 D**	**460 D**
	10/14/04	1.2	0.12 U	**28**	**15,000 J**	94 J	3.8	0.12 U	**22,000 J**	**770 J**
	04/13/05	0.2 U	0.2 U	**200 U**	**10,000**	**200 U**	2.3	0.2 U	**16,000**	**800**
	10/13/05	0.2 U	0.2 U	**13**	**8,600**	**100 U**	1.5	0.2 U	**7,800**	**1,900**
	07/12/06	50 U	**50 U**	**16 JD**	**6,300 D**	53 D	**50 U**	50 U	**14,000 D**	**540 D**
	10/17/06	0.23 J	0.5 U	**17**	**11,000 D**	77 D	0.63	0.5 U	**3,000 D**	**4,500 D**
	06/14/07	100 U	**100 U**	**100 U**	**11,000 D**	72 JD	**100 U**	100 U	**24,000 D**	**850 D**
	10/17/07	10 U	**10 U**	**5 D**	**3,400 D**	23 D	**10 U**	10 U	**3,100 D**	**240 D**
	05/07/08	50 U	**50 U**	**18 JD**	**7,500 D**	73 D	**50 U**	50 U	**24,000 D**	**410 D**
	10/28/08	13 U	**13 U**	**4.5 JD**	**3,400 D**	23 D	**13 U**	13 U	**6,600 D**	**180 D**
	06/25/09	50 U	**50 U**	**23 D**	**12000 D**	93 D	**50 U**	50 U	**30000 D**	**510 D**
MW1-5	08/23/95	5.8 J	1 U	**1 U**	17	1.3	1 U	1 U	1.9	**140**
	12/05/95	110 J	1 U	**1 U**	**74 J**	16	1 U	1 U	**7.3**	**4300 J**
	03/06/96	34	0.5 U	**0.5 U**	60	7	0.5 U	0.5 U	3	**1100**
	06/20/96	29 J	0.5 U	.24 J	**93 J**	6.5	0.5 U	0.5 U	1.7	**1500 J**
	06/14/99	9	3 U	**3 U**	9	2 J	3 U	3 U	2 J	**260**
	10/21/99	9.6	0.5 U	**0.5 U**	0.50	0.50	0.5 U	0.5 U	0.5 U	**18**
	04/25/00	1.1	0.5 U	**0.5 U**	1.2	0.5 U	0.5 U	0.5 U	0.5 U	**30**
	06/07/00	6.9	0.5 U	**0.5 U**	1.8	0.64	0.5 U	0.5 U	1.6	**22**
	07/25/00	1.8	0.5 U	**0.5 U**	3.4	0.5 U	0.5 U	0.5 U	0.5 U	**31**
	11/06/00	1.7	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**7**
	04/26/01	1 U	1 UJ	**1 U**	1 U	1 U	1 U	1 UJ	1 U	**24**
	06/20/01	1.5	0.12 U	0.12 U	0.46 J	0.28 J	0.11 U	0.12 U	0.46 J	**32**
	07/31/01	0.5 J	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**13**
	10/30/01	1.7	1 U	**1 U**	0.5 J	1 U	1 U	1 U	1 U	**3.5**
	05/01/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.7**

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MW1-5 (cont.)	06/17/02	0.93	0.5 U	**0.5 U**	0.74	0.16 J	0.5 U	0.5 U	0.85	**11**
	07/24/02	0.65	0.5 U	**0.5 U**	0.63 J	0.5 U	0.5 U	0.5 U	0.66	**2.5**
	10/25/02	15	0.5 U	**0.5 U**	0.82	0.5 U	0.5 U	0.5 U	0.8	**5.6**
	04/29/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**5.1**
	10/15/03	2.0	0.5 U	**0.5 U**	0.41 J	0.22 J	0.5 U	0.5 U	0.24 J	**3.1**
	04/22/04	0.24 J	0.5 U	**0.5 U**	0.27 J	0.5 U	0.5 U	0.5 U	0.24 J	**0.83**
	10/14/04	1.4	0.12 U	0.12 U	0.56	0.31 J	0.11 U	0.12 U	0.55	**2**
	04/13/05	0.2 U	0.2 U	0.2 U	2	0.2 U	0.2 U	0.2 U	**10**	**0.9**
	10/12/05	3.0	0.2 U	0.2 U	0.7	0.2 U	0.2 U	0.2 U	0.5	**5.9**
	07/12/06	0.48 J	0.5 U	0.2 U	0.40 J	0.5 U	0.5 U	0.5 U	0.5 U	**0.91**
	10/16/06	6.8	0.5 U	0.3 U	0.9	0.4 J	0.5 U	0.5 U	0.65	**11**
	06/14/07	0.44 J	0.5 U	**0.5 U**	0.27 J	0.5 U	0.5 U	0.5 U	0.27 J	**0.7**
	10/17/07	2.1	0.5 U	0.2 U	0.55	0.17 J	0.5 U	0.5 U	0.34 J	**4**
	05/12/08	0.16 J	0.5 U	0.2 U	0.26 J	0.10 J	0.5 U	0.5 U	0.27 J	0.42
	10/29/08	1.4	0.5 U	**0.5 U**	0.54	0.24 J	0.5 U	0.5 U	0.39 J	**2.2**
	06/26/09	3.4	0.5 U	**0.59**	0.51	0.59	0.5 U	0.5 U	0.47 J	**6.6**
MW1-09	08/21/95	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	12/05/95	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	03/05/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/07/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	**0.5 U**
	06/17/02	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
	04/23/04	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U
	07/13/06	0.5 UJ	0.5 UJ	0.2 UJ	0.17 J	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.2 UJ
	05/12/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
MW1-16	08/31/95	**12000 J**	**15 J**	**680 J**	**14000 J**	**520 J**	.51 J	**5600 J**	**250 J**	**12000 J**
	06/20/96	**30000 J**	**35 J**	**180 J**	**3100 J**	**180 J**	1.3 J	**430 J**	**34 J**	**2200 J**
	06/14/99	**15000**	**17**	**48**	**6800**	**160**	1 J	140	**530**	**1700**
	10/21/99	**6500**	**9**	**5**	28	26	1.2	23	**9.2**	**28**
	04/26/00	**1700 J**	0.5 U	**0.5 U**	**70 J**	7.4	0.69	16	3.3	**4.3**
	06/07/00	**2500**	2.7	**2 J**	13	13	1 J	29	**20**	**6.6**
	07/25/00	**2300 J**	**50 U**	**50 U**	50 U	50 U	**50 U**	50 U	**50 U**	**50 U**
	11/06/00	**3900**	4.2	**1.3**	12	16	1 U	21 J	4.1	**1 U**
	04/27/01	**1100 J**	1.6 J	**1 U**	2.4	7.5	0.4 J	7.2 J	2.2	**19**
	06/20/01	**2900**	**7 J**	**23 J**	**9300**	98	**5.5 U**	28	**370**	**1400**
	07/31/01	**1900 J**	1.9	**2.2**	60	12	1 U	15	**8.3**	**68 J**
	10/30/01	**3400 J**	4.1	**2.1**	13	17	1 U	13	3.5	**11**
	05/01/02	**1200 J**	2.5 U	**2.5 U**	3.9 J	7.9 J	2.5 U	5.6 J	2.5 U	**2.7 J**
	06/17/02	**10000 D**	**50 U**	**42 J**	**24000 D**	**240 D**	**50 U**	38 J	**150 D**	**3000D**
	07/24/02	**3200 J**	**5 U**	**5 U**	**340 J**	17 J	**5 U**	10 J	**5.5 J**	**86 J**
	10/25/02	**9000 J**	**25 U**	**25 U**	**190 J**	38 J	**25 U**	25 U	**25 U**	**80 J**
	04/29/03	330 D	0.5 U	**0.5 U**	1.6	3.9	0.5 U	0.52	1.3	**2.1**
	10/15/03	**1700**	**5.0 U**	**5.0 U**	6.2	13	**5.0 U**	5.3	2.4 J	**5.5**
	04/21/04	160 D	0.21 J	0.24 J	1.8	3	0.13 J	0.20 J	1	**1.7**
	10/13/04	**4200 J**	3.7	**1.1**	11	23	0.42 J	10	4.5	**9.3**
	04/13/05	88	0.2 U	0.2 U	1.2	2.8	0.2 U	0.2 U	0.6	**0.6**
	10/13/05	220	0.2 J	0.2 J	13 J	7.0 J	0.2 U	0.2 U	2.0 J	**5.9 J**

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MW1-16 (cont.)	07/14/06	240 D	1 U	0.40 D	3.3 D	3.2 D	1 U	1 U	1.2 D	**2.8 D**
	10/17/06	**1000 D**	0.47 J	**0.63**	**440 D**	26	0.13 J	0.23 J	2.6	**290 D**
	06/14/07	40	0.5 U	0.13 J	1.6	2.2	0.5 U	0.5 U	0.7	**0.89**
	10/17/07	98 D	2.5 U	**1 U**	6.5 D	6.1 D	2.5 U	2.5 U	1.8 JD	**2.5 D**
	05/12/08	17	0.5 U	0.14 J	1.1	1.9	0.5 U	0.5 U	0.65	**0.68**
	10/29/08	68 D	0.14 JD	0.20 JD	12 D	6.7 D	1.0 U	1.0 U	1.0 D	**6.3 D**
	06/25/09	37	0.5 U	0.23	29	2.6	0.5 U	0.08 J	3.1	**11**
MW1-17	08/29/95	1 U	1 U	**1 U**	6.4	0.93 J	1 U	1 U	1 U	**6.9**
	12/04/95	1 U	1 U	**1 U**	5.1	1 U	1 U	1 U	1 U	**4.3**
	03/06/96	0.5 U	0.5 U	**0.5 U**	0.32 J	0.29 J	0.5 U	0.5 U	0.5 U	0.47 J
	06/24/96	0.5 U	0.20 J	**0.5 U**	1.4 U	0.51	0.40 J	0.5 U	0.5 U	**1.2 U**
	06/07/00	0.10 J	0.5 U	**0.5 U**	0.5 U	0.64	0.5 U	0.5 U	0.30 J	**0.5 U**
	06/20/01	0.12 J	0.12 U	0.12 U	0.12 U	0.71	0.11 U	0.12 U	0.12 U	0.22 U
	06/17/02	0.11 J	0.5 U	**0.5 U**	0.5 U	0.43 J	0.5 U	0.5 U	0.5 U	**0.66**
	04/29/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.4**
	04/22/04	0.5 U	0.5 U	**0.5 U**	3.4	0.31 J	0.5 U	0.5 U	0.89	**3.8**
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/10/06	0.5 UJ	0.5 UJ	0.25 J	50 J	0.23 J	0.5 UJ	0.5 UJ	0.5 UJ	**14 J**
	06/14/07	0.5 U	0.5 U	0.31 J	**76 D**	0.5 U	0.5 U	0.5 U	0.5 U	**14**
	05/07/08	0.5 U	0.5 U	0.19 J	33	0.14 J	0.5 U	0.5 U	0.5 U	**5.9**
	06/18/09	0.5 U	0.5 U	0.43	**100 D**	0.22 J	0.5 U	0.5 U	0.13 J	**18**
MW1-20	08/30/95	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	12/08/95	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	03/11/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/27/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/21/99	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/21/99	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/26/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	07/25/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/31/00	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	04/27/01	NA	NA	NA	NA	NA	NA	NA	NA	NA
	07/31/01	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	10/30/01	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	05/01/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	07/25/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/25/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/29/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/14/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/21/04	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/13/04	0.091 U	0.12 U	0.12 U	0.12 U	0.15 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/13/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	10/12/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/16/06	0.5 U	0.5 U	0.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.05 J
	06/13/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/19/07	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MW1-20 (cont.)	05/07/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	10/28/08	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/24/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
MW1-25	08/17/95	4.8	1 U	**7.3**	**440 R**	35 R	1 U	1 U	**98 R**	**340 R**
	12/06/95	3.9	1 U	**6.1**	**630 R**	38 R	1 U	1 U	**74 R**	**230 R**
	03/11/96	0.50 U	0.50 U	**1.1**	**260**	6.3	0.50 U	0.50 U	**11**	**44**
	06/25/96	0.50 U	0.50 U	**4.7 J**	**630 R**	45 R	0.50 U	0.50 U	**74 R**	**240 R**
	06/08/00	6.9	0.30 J	**7.2**	**2000**	41	0.50 U	0.50 U	**39**	**260**
	08/06/02	8.6 J	**10 U**	**7.6 J**	**2000 D**	41 D	**10 U**	10 U	**20 D**	**240 D**
	06/19/03	67 U	NA	**67 U**	**1800**	34	**67 U**	67 U	**14**	**210**
	04/22/04	5.9 D	2.5 U	**6.6 D**	**1600 D**	33 D	2.5 U	2.5 U	**7.5 D**	**170 D**
	07/13/06	6 D	**5 U**	**7.3 D**	**1,700 D**	37 D	**5 U**	5 U	4.3 JD	**270 D**
	05/08/08	4.5 D	2.5 U	**4.8 D**	**1,200 JD**	28 D	2.5 U	2.5 U	1.3 JD	**210 D**
MW1-28	12/07/95	1.1	1 U	**5.1**	**720 R**	58 R	1 U	1 U	2.3	**420 R**
	03/08/96	2.1	0.50 U	**5**	**320**	78	0.50 U	0.50 U	1.6	**480**
	06/25/96	2.4 J	0.50 U	**6.3 J**	**540 R**	78 R	0.50 U	0.50 U	2.2 J	**480 R**
	09/09/96	2.3	0.50 U	**5.4**	**510 R**	66 R	0.50 U	0.50 U	1.2	**540 R**
	06/07/00	3.2	0.50 U	**5.1**	**1300 J**	74	0.50 U	0.50 U	0.81	**520**
	08/06/02	4.6 J	**10 U**	**5.4 J**	**1500 D**	84 D	**10 U**	10 U	**10 U**	**600 D**
	06/19/03	50 U	NA	**50 U**	**1200**	34	**50 U**	50 U	**50 U**	**470**
	04/22/04	3.9	0.50 U	**5.3**	**1300 D**	71 D	0.50 U	0.50 U	0.52	**540 D**
	07/13/06	6.1 D	**5 U**	**7.2 D**	**1,500 D**	94 D	**5 U**	5 U	1.6 JD	**710 D**
	05/08/08	6.1 D	2.5 U	**5.7 D**	**1,400 D**	78 D	2.5 U	2.5 U	0.90 JD	**650 D**
MW1-38	06/19/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/27/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	09/10/96	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/23/04	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	07/13/06	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	05/12/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
MW1-39	06/17/96	0.50 U	0.50 U	**0.50 U**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.80**
	06/27/96	0.50 U	0.50 U	**0.50 U**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**1 U**
	09/10/96	0.50 U	0.50 U	**0.50 U**	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.76**
	06/08/00	0.50 U	0.50 U	**0.50 U**	0.40 J	0.50 U	0.50 U	0.50 U	0.50 U	**2**
	08/06/02	0.50 U	0.50 U	**0.50 U**	0.32 J	0.50 U	0.50 U	0.50 U	0.50 U	**1.8**
	06/19/03	1.0 U	NA	**1.0 U**	0.56	1.0 U	1.0 U	1.0 U	1.0 U	**1.3**
	04/23/04	0.50 U	0.50 U	**0.50 U**	0.33 J	0.50 U	0.50 U	0.50 U	0.50 U	**2**
	07/13/06	0.5 U	0.5 U	0.2 U	0.45 J	0.5 U	0.5 U	0.5 U	0.5 U	**2.7**
	05/12/08	0.5 U	0.5 U	0.2 U	0.43 J	0.5 U	0.5 U	0.5 U	0.5 U	**2.3**
MW1-41	06/21/99	NA	NA	NA	NA	NA	NA	NA	NA	NA
	10/21/99	0.5 U	0.5 U	**0.5 U**	0.60	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/26/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/08/00	0.20 J	0.5 U	**0.5 U**	0.82	0.5 U	0.5 U	0.5 U	0.5 U	**0.53**
	07/24/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	11/02/00	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	04/26/01	1 U	1 UJ	**1 U**	1 U	1U	1 U	1 UJ	1 U	**1 U**
	06/20/01	0.10 J	0.12 U	0.12 U	0.40 J	0.14 U	0.11 U	0.12 U	0.12 U	0.40 J

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MW1-41 (cont.)	07/30/01	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**0.6 J**
	10/29/01	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**0.5 J**
	04/30/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/19/02	0.5 U	0.5 U	**0.5 U**	0.41 J	0.5 U	0.5 U	0.5 U	0.5 U	0.43 J
	07/23/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/25/02	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	04/30/03	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	10/15/03	0.5 U	0.5 U	**0.5 U**	0.37 J	0.5 U	0.5 U	0.5 U	0.5 U	0.28 J
	04/22/04	0.5 U	0.5 U	**0.5 U**	0.30 J	0.5 U	0.5 U	0.5 U	0.5 U	0.30 J
	10/13/04	0.1 J	0.12 U	0.12 U	0.41 J	0.15 U	0.11 U	0.12 U	0.12 U	0.35 J
	04/12/05	0.2 U	0.2 U	0.2 U	0.3	0.2 U	0.2 U	0.2 U	0.2 U	0.3
	10/12/05	0.2 U	0.2 U	0.2 U	0.5	0.2 U	0.2 U	0.2 U	0.2 U	0.3
	07/10/06	0.5 U	0.5 U	0.2 U	0.26 J	0.5 U	0.5 U	0.5 U	0.5 U	0.23
	10/16/06	0.5 U	0.5 U	0.3 U	0.34 J	0.5 U	0.5 U	0.5 U	0.5 U	0.22
	06/13/07	0.5 U	0.5 U	0.2 U	0.25 J	0.5 U	0.5 U	0.5 U	0.5 U	0.21
	10/18/07	0.5 U	0.5 U	0.2 U	0.31 J	0.5 U	0.5 U	0.5 U	0.5 U	0.18 J
	05/08/08	0.5 U	0.5 U	0.2 U	0.27 J	0.11 J	0.5 U	0.5 U	0.5 U	0.19 J
	10/28/08	0.080 J	0.5 U	**0.5 U**	0.32 J	0.12 J	0.5 U	0.5 U	0.5 U	0.16 J
	06/19/09	0.5 U	0.5 U	0.2 U	0.26 J	0.07 J	0.5 U	0.5 U	0.5	0.2
Navy Well #5	12/08/95	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	03/03/98	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/02/99	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/07/00	0.5 U	0.5 U	**0.5 U**	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/19/01	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	06/27/02	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/30/03	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/23/04	0.091 U	0.12 U	0.12 U	0.14 J	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	06/16/04	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/14/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	05/09/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/18/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
PUD Well	12/08/95	1 U	1 U	**1 U**	1 U	1 U	1 U	1 U	1 U	**1 U**
	03/03/98	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/02/99	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/08/00	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	06/19/01	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	07/01/02	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/30/03	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/23/04	0.091 U	0.12 U	0.12 U	0.12 U	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/14/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/14/07	0.5 U	0.5 U	**0.5 U**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.5 U**
	05/09/08	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/17/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U

Table 6-1 (Continued)
Summary of Analytical Results for OU 1 Groundwater Sampling Through June 2009

Notes:
Bolded value indicates it exceeds or is equal to the RG for drinking water. Shaded rows indicate the most current sampling period results.
Data from 1995 to April 2004 are from U.S. Navy 2005a; data from October 2004 through 2008 are from U.S. Navy 2008a and 2009g; and data from 2009 are from U.S. Navy 2009h.
D - The reported result is from a dilution.
DCA - dichloroethane
DCE - dichloroethene
E - The value shown exceeds the instrument calibrating range.
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
µg/L - microgram per liter
MRL - method reporting limit
NA - not analyzed
PCE - tetrachloroethene
R - Quality control indicates the data are not usable.
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-2
Summary of 1,4-Dioxane Analytical Results for OU 1 Groundwater Sampling in 2006

Location	Sampling Date	1,4-Dioxane[a] (µg/L)
1MW-1	07/10/06	1.1
MW1-2	07/10/06	14
MW1-3	07/12/06	1.0 U
MW1-4	07/12/06	1.0 U
MW1-5	07/12/06	1.0 U
MW1-9	07/13/06	1.0 U
MW1-16	07/14/06	1.0 U
MW1-17	07/10/06	1.0
MW1-20	07/12/06	1.0 U
MW1-25	07/13/06	29
MW1-28	07/13/06	29
MW1-38	07/13/06	4.1
MW1-39	07/13/06	1.9
MW1-41	07/10/06	8.5
Navy Well #5	07/14/06	1.0 U
PUD Well	07/14/06	1.0 U

[a]No remediation goal was established for 1,4-dioxane. The current Model Toxics Control Act cleanup level for 1,4-dioxane is 4.0 µg/L.

Notes:
Data from 2006 are from U.S. Navy 2007a.
µg/L - microgram per liter
U - The compound was analyzed for, but was not detected ("nondetected") at or above the method reporting limit/method detection limit.

Table 6-3
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
Remediation Goal		N/A	59	1.9	N/A	33,000	4.2	41,700	56	2.9
DB-14	09/05/95	1 U	1 UJ	1 U	1 U	1 UJ	1 U	1 U	1U	1 U
	12/04/95	1 U	1 U	1 U	1.9	1U	1 U	1 U	1 U	1 U
	03/13/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	07/01/96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/06/00	0.5 U	0.5 U	0.5 U	0.59	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/22/01	0.091 U	0.12 U	0.12 U	0.7	0.14 U	0.11 U	0.12 U	0.12 U	0.22 U
	06/19/02	0.50 U	0.5 U	0.5 U	0.53	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/29/03	0.50 U	0.50 U	0.50 U	1.8	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	04/23/04	0.50 U	0.50 U	0.50 U	0.63	0.50 U	0.50 U	0.50 U	0.12 J	0.50 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.6	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	1.1	0.5 U	0.5 U	0.5 U	0.18 J	0.16 J
	05/09/08	0.5 U	0.5 U	0.2 U	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/25/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
MA-09	09/05/95	1 U	1 UJ	1 U	4	1 UJ	1 U	1 U	1 U	1.3
	12/05/95	1 U	1 U	1 U	14	1 U	1 U	1 U	1 U	**5.4**
	03/14/96	0.29 J	0.5 U	0.5 U	11	0.5 U	0.5 U	0.5 U	1.2	**8**
	07/02/96	0.5 U	0.5 U	0.5 U	0.79	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/06/00	0.5 U	0.5 U	0.5 U	3	0.5 U	0.5 U	0.5 U	0.63	0.64
	06/22/01	1.2	0.12 U	0.12 U	37	0.51	0.11 U	0.12 U	4.7	**8.3**
	06/27/02	0.13 J	0.5 U	0.5 U	6.3	0.5 U	0.5 U	0.5 U	0.82	1.4
	04/29/03	0.50 U	0.50 U	0.50 U	18	0.50 U	0.50 U	0.50 U	3.5	**4.9**
	04/21/04	0.22 J	0.50 U	0.50 U	15	0.21 J	0.50 U	0.50 U	3.2	1.9
	04/14/05	0.2 J	0.2 U	0.2 U	14 J	0.2 J	0.2 U	0.2 U	3.1 J	2.5 J
	07/12/06	0.5 U	0.5 U	0.2 U	2.3	0.5 U	0.5 U	0.5 U	0.5 U	0.3
	06/15/07	0.5 U	0.5 U	0.5 U	10	0.5 U	0.5 U	0.5 U	1.6	1.8
	5/9/2008	0.5 U	0.5 U	0.2 U	6.3	0.09 J	0.5 U	0.5 U	1.3	1.2
	06/24/09	0.5 U	0.5 U	0.2 U	12	0.11 J	0.5 U	0.5 U	2.3	1.6
MA-11	09/06/95	1 U	1 U	1 U	.51 J	1 UJ	1 U	1 U	1 U	1 U
	12/06/95	1 U	1 U	1 U	10	1 U	1 U	1 U	1 U	**3.5**
	03/13/96	0.43 J	0.5 U	0.5 U	13	0.5 U	0.5 U	0.5 U	0.5 U	**5.9**
	07/02/96	0.5 U	0.5 U	0.5 U	0.52	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	06/06/00	1.2	0.5 U	0.5 U	33	0.56	0.5 U	0.5 U	7.9	**9.2**
	06/22/01	0.16 J	0.12 U	0.12 U	4.6	0.14 U	0.11 U	0.12 U	0.66	0.98
	06/19/02	0.54	0.5 U	0.5 U	22	0.24 J	0.5 U	0.5 U	4.2	**5.6**
	04/30/03	0.50 U	0.50 U	0.50 U	33	0.50 U	0.50 U	0.50 U	6.1	**6.0**
	04/21/04	0.33 J	0.50 U	0.50 U	23	0.31 J	0.50 U	0.50 U	4.9	**4.0**
	04/14/05	0.2 U	0.2 U	0.2 U	11	0.2 U	0.2 U	0.2 U	2.5	1.4
	07/12/06	0.5 U	0.5 U	0.2 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	0.54	0.5 U	0.5 U	0.5 U	0.5 U	0.07 J

Table 6-3 (Continued)
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
MA-11	05/09/08	0.07 J	0.5 U	0.2 U	10	0.15 J	0.5 U	0.5 U	2.1	1.8
(cont.)	06/24/09	0.5 U	0.5 U	0.2 U	3.8	0.5 U	0.5 U	0.5 U	0.67	0.38
MA-12	03/14/96	5 U	0.5 U	0.56	180 J	1.6	0.5 U	0.5 U	26	**56 J**
	07/01/96	11	0.5 U	1	480 J	3.5	0.5 U	0.5 U	**64 J**	**56 J**
	06/11/99	15	3 U	**2 J**	710	8	3 U	3 U	**130**	**150**
	10/20/99	12	0.5 U	**1.9**	600	5.5	0.5 U	0.5 U	**110**	**130**
	04/25/00	21	0.5 U	1.3	630 J	10	0.5 U	0.5 U	**190 J**	**250 J**
	06/06/00	16	5 U	**5 U**	670	5.5	**5 U**	5 U	**110**	**140**
	07/25/00	25 U	25 U	**25 U**	750 J	25 U	**25 U**	25 U	**180 J**	**140 J**
	11/09/00	14	1 U	1.2	680	5.2	1 U	1 U	**170**	**140**
	04/27/01	15	1 UJ	1.6	600J	12	1 U	1UJ	**100J**	**92 J**
	06/22/01	15	0.29 U	0.98 J	520	6.8	0.28 U	0.28 U	**62**	**80**
	07/31/01	17	1 U	1.1	500 J	28 J	1 U	1 U	**90**	**150**
	10/30/01	6.8	1 U	0.8 J	260 J	2.7	1 U	1 U	**82**	**67**
	05/01/02	7 J	1 U	1 U	440 J	3.1 J	1 U	1 U	**96 J**	**49 J**
	06/19/02	7.2	0.5 U	0.7	340 D	3.0	0.5 U	0.5 U	53 D	**57 D**
	07/25/02	8.3 J	1 U	1.2 J	580 J	4.7 J	1 U	1 U	**86 J**	**94 J**
	10/25/02	5.1 J	1.3 U	1.3 U	420 J	2.7 J	1.3 U	1.3 U	**59 J**	**55 J**
	04/30/03	4.0 D	1.0 U	1.0 U	390 D	2.8 D	1.0 U	1.0 U	**60 D**	**49 D**
	10/23/03	3.5	0.50 U	0.52	160	1.3	0.50 U	0.50 U	28	**45**
	04/21/04	5.7	0.50 U	0.81	430 D	3.2	0.50 U	0.50 U	**83 D**	**46**
	10/14/04	11	0.12 U	**2**	660 J	4.7	0.11 U	0.12 U	**57**	**110 J**
	04/14/05	7.3	0.2 U	0.8	450	5.4	0.2 U	0.2 U	**83**	**51**
	10/13/05	4.9	0.4	1.3	540	4.8	0.2 U	0.2 U	47	**92**
	07/12/06	6.0 D	2.5 U	**2.3 D**	800 D	11 D	2.5 U	2.5 U	**110 D**	**120 D**
	10/17/06	3.3	0.5 U	1.2 D	460 D	4.1	0.5 U	0.5 U	**59**	**75**
	06/15/07	3.9 D	1.0 U	1.3 D	840 D	5.6 D	1.0 U	1.0 U	**150 D**	**120 D**
	10/18/07	0.67	0.5 U	0.29	130 D	0.83	0.5 U	0.5 U	12	**28**
	05/09/08	4.3 D	1.0 U	1.3 D	670 D	5.8 D	1.0 U	1.0 U	**140 D**	**93 D**
	10/28/08	3.0 D	1.3 U	1.2 JD	400 D	3.1 D	1.3 U	1.3 U	**65 D**	**49 D**
	06/17/09	3.9 D	2.5 U	**1.9 D**	1000 D	9 D	2.5 U	2.5 U	**170 D**	**110 D**
SP1-1	09/05/95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.66 J
	12/05/95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	03/13/96	0.5 U	0.5 U	0.5 U	170 J	1.8	0.5 U	0.5 U	0.5 U	**420 J**
	07/02/96	0.5 U	0.5 U	0.5 U	7.4	0.76	0.5 U	0.5 U	0.5 U	**31 J**
	09/10/96	0.2 J	0.5 U	0.5 U	0.33 J	0.5 U	0.5 U	0.5 U	0.5 U	1.1
	06/11/99	3 U	3 U	**3 U**	4	3 U	3 U	3 U	3 U	**32**
	10/20/99	0.5 U	0.5 U	0.5 U	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/25/00	0.5 U	0.5 U	0.5 U	32	2.5	0.5 U	0.5 U	1.7	**210 J**
	07/25/00	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	11/09/00	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1

Table 6-3 (Continued)
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2009

Location	Sampling Date	Analyte Concentration (µg/L)								
		1,1-DCA	1,2-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride
SP1-1 (cont.)	04/27/01	1 U	1 UJ	1 U	1.3	0.7 J	1 U	1 UJ	1 U	**8.4**
	07/31/01	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	10/30/01	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
	05/01/02	0.5 U	0.5 U	0.5 U	5	1	0.5 U	0.5 U	0.5 U	**43**
	07/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	10/25/02	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	04/29/03	0.50 U	0.50 U	0.50 U	2.2	0.80	0.50 U	0.50 U	0.50 U	**31**
	10/23/03	0.50 U	0.50 U	0.50 U	0.17 J	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	04/21/04	0.20 J	0.50 U	0.50 U	0.16 J	0.34 J	0.50 U	0.50 U	0.50 U	1.1
	10/14/04	0.26 J	0.12 U	0.12 U	0.14 J	0.18 J	0.11 U	0.12 U	0.12 U	0.22 U
	04/14/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	10/13/05	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
	07/12/06	0.13 J	0.5 U	0.2 U	0.17 J	0.5 U	0.5 U	0.5 U	0.5 U	0.06 J
	10/17/06	0.14 J	0.5 U	0.3 U	0.16 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.11 J	0.5 U	0.5 U	0.14 J	0.5 U	0.5 U	0.5 U	0.5 U	0.05 J
	05/08/08	0.12 J	0.14 J	0.2 U	0.2 J	0.14 J	0.5 U	0.5 U	0.5 U	0.13 J
	06/24/09	0.5 U	0.08 J	0.2 U	0.32 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
TF-19	09/05/95	1 U	1 U	1 U	4	1 U	1 U	1 U	1 U	.92 J
	12/04/95	1 U	1 U	1 U	8.4	1 U	1 U	1 U	1 U	2.8
	03/12/96	0.39 J	0.5 U	0.5 UJ	18	0.5 U	0.5 U	0.5 U	1.3 J	**19**
	07/01/96	0.5 U	0.5 U	0.5 U	5.9	0.5 U	0.5 U	0.5 U	0.68	2.3
	06/06/00	0.4 J	0.5 U	0.5 U	12	0.2 J	0.5 U	0.5 U	2.3	**3.1**
	06/22/01	0.55	0.12 U	0.12 U	18	0.22 J	0.11 U	0.12 U	2.1	**3.2**
	06/19/02	0.22 J	0.5 U	0.5 U	8.5	0.5 U	0.5 U	0.5 U	1.3	1.9
	04/29/03	0.50 U	0.50 U	0.50 U	26	0.50 U	0.50 U	0.50 U	4.9	**6.1**
	04/23/04	0.13 J	0.50 U	0.50 U	9	0.17 J	0.50 U	0.50 U	1.6	1.1
	04/14/05	0.2 U	0.2 U	0.2 U	11	0.2 U	0.2 U	0.2 U	2.4	1.8
	07/12/06	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/15/07	0.5 U	0.5 U	0.5 U	6.5	0.5 U	0.5 U	0.5 U	0.98	1.0
	05/09/08	0.5 U	0.5 U	0.2 U	0.18 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U
	06/25/09	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U

Notes:
Bolded value indicates it exceeds or is equal to the remediation goal. Shaded rows indicate the most current sampling period results.
Data from 1995 to April 2004 are from U.S. Navy 2005a; data from October 2004 through 2008 are from U.S. Navy 2008a and 2009g; and data from 2009 are from U.S. Navy 2009h.
D - The reported result is from a dilution.
DCA - dichloroethane
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
µg/L - microgram per liter

Table 6-3 (Continued)
Summary of Analytical Results for OU 1 Surface Water and Seep Sampling Through June 2009

MRL - method reporting limit
N/A - not applicable
PCE - tetrachloroethene
TCA - trichloroethane
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-4
Summary of PCB Aroclor Analytical Results for OU 1 Seep Sampling Location

Location	Sampling Date	Total PCBs[a] (µg/L)
Remediation Goal		0.04
SP1-1	Spring 1990	**1.8**
	Fall 1991	**1.5**
	09/05/95	**0.16**
	12/05/95	**0.15**
	03/13/96	**0.2**
	07/02/96	**0.24 J**
	10/10/96	**0.13**
	06/07/00	**0.42**
	06/17/02	**0.45**
	04/21/04	**0.42**
	07/12/06	**0.29**
	05/08/08	**0.27**

[a]Data are from U.S. Navy 2008a.

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 method reporting limit, but greater than or equal to the method detection limit.
µg/L - microgram per liter
PCBs - polychlorinated biphenyls

Table 6-5
Summary of Analytical Results for PCBs and Metals in OU 1 Sediment From April 1996 Through June 2009

Location	Sampling Date	TOC (%)[c]	PCBs (µg/kg or mg/kg OC)[d]			Metals (mg/kg)						
			Aroclor 1254	Aroclor 1260	Total PCBs	Arsenic	Beryllium	Chromium	Lead	Mercury	Nickel	Zinc
SQS Screening Level (mg/kg)[a]		NA	NA	NA	12	57	NA	260	450	0.41	NA	410
AET Screening Level (µg/kg dry weight)		NA	NA	NA	130	NA	NA	NA	NA	NA	NA	NA
DB-05	April 1996	0.68	3 U	3 U	8 U	3	0.2 U	19	8	0.05 U	15	26
	June 2000	N/A	10 U	10 U	20 U	4.3	0.16	25.9	8.58	0.06	21.1 J	33.4 J
	June 2004	0.79	10 U	10 U	20 U	2.9	0.14	20.2	7.91	0.04	18.9	31.1
	June 2009	1.42	0.18 J [e]	0.63 U [e]	0.18 J[e]	3.71	0.146	48.5 J	10.8	0.058 J	24.8 J	43.7 J
DB-07	April 1996	0.56	3 U	3 U	8 U	3	0.2 U	15	6	0.05 U	14	22
	June 2000	N/A	10 U	10 U	20 U	9.6	0.12	27.7	129	0.08	18.8 J	216 J
	June 2004	1.12	0.41 J [e]	0.89 U [e]	0.41 J [e]	6.3	0.16	23.8	40.2	0.17	25.2	74.7
	June 2009	0.51	7.4 U	7.4 U	15 U	2.78	0.085	15.8 J	5.85	0.034 J	16.2 J	25.4 J
DB-08	April 1996	0.74	3 UJ	3 UJ	8 UJ	4	0.2 U	20	7	0.05 U	17	30
	June 2000	N/A	10 UJ	10 UJ	10 UJ	3.2	0.13	23	7.13	0.05	22.9 J	30.4 J
	June 2004	0.69	10 U	10 U	20 U	4.1	0.17	25.6	8.71	0.04	26.8	37
	June 2009	1.43	0.20 J[e]	0.59 U [e]	0.20 J [e]	3.6	0.131	27.6 J	17.6	0.074 J	24.4 J	51.7 J
DB-08 FD	June 2009	1.35	N/A	N/A	N/A	3.78	0.142	28.2 J	17.4	0.075 J	23.6 J	57.5 J
MA-09	April 1996	0.48	56	6 J	62	3	0.2 U	21	6	0.05 U	25	27
	June 2000	N/A	200	10 U	**200**	5.5	0.21	43.4	13.9	0.07	37.4 J	58.5 J
	June 2002	0.55	3.7 J	12 U	3.7 J	2.6	0.18	29.7 J	3.21	0.03	43.9 J	25.5 J
	June 2004	3.14	2.68 [e]	0.32 U [e]	2.68 [e]	10.4	0.25	37.3	50.6	0.04	48.3	173
	June 2009	1.18	1.36 [e]	0.68 U [e]	1.36 [e]	5.73	0.138	29.2	6.93	0.026 J	26.9 J	42.2 J
MA-09 FD	April 1996	0.53	141	14	**155**	6	0.2 U	32	6	0.05 U	24	27
MA-10	April 1996	2.03	1.08 [e]	0.74 U [e]	1.08 [e]	5	0.2 U	146	11	0.06	33	69
MA-11	April 1996	3.40	1.56 [e]	0.29 U [e]	1.56 [e]	21	0.2 U	104	12	0.05	39	80
	June 2000	N/A	0.5 [e]	0.29 U [e]	0.5 [e]	7	0.17	74.5	12.1	0.07	28.3 J	68.3 J
	June 2004	1.03	0.97 U [e]	0.97 U [e]	1.94 U [e]	5	0.21	28.4	5.04	0.03	27.8	29
	June 2009	1.91	2.88 U [e]	1.47 U [e]	2.88 U [e]	21.3	0.249	**269 J**	26.8 J	0.120 J	42.3 J	138 J
MA-14	June 2000	N/A	140	10 U	**140**	6.2	0.16	34.1	20.8	0.09	33 J	81.8 J
	June 2002	0.59	9.7 J	13 U	9.7 J	2.5	0.16	20.9 J	10	0.03	32.4 J	63.7 J
	June 2004	2.16	0.6 [e]	0.46 U [e]	0.6 [e]	3.9	0.15	22.5	13.5	0.02	29.4	84.3
	June 2009	2.90	3.45 [e]	0.45 U [e]	3.45 [e]	6.94	0.169	45.7 J	29.8	0.114 J	30.0 J	71.5
MA-14 FD	June 2002	1.16	0.83 J [e]	0.1 U [e]	0.83 J [e]	1.6	0.14	15.4 J	7.47	0.02	21.8 J	50.1 J
	June 2004	2.95	0.75 [e]	0.34 U [e]	0.75 [e]	4.9	0.22	29.1	15.7	0.03	31.2	74.5
TF-18	April 1996	0.56	3 U	3 U	8 U	2	0.2 U	19	7	0.05 U	13	21
	June 2000	N/A	6 J	10 U	6 J	3.3	0.14	25.1	10.9	0.05	20.4 J	36 J
	June 2004	28.30	4.7 J	10 U	4.7	2.6	0.12	19.9	7.67	0.04	23.4	35.9
	June 2009	0.59	2.4 JP	6.9 U	14 U	2.29	0.082	14.5 J	5.25 J	0.026 J	12.6 J	21.8 J
TF-20	April 1996	0.46	3 U	3 U	8 U	3	0.2 U	14	6	0.05 U	15	34
	June 2000	N/A	10 U	10 U	20 U	3.3	0.14	26.4	8.12	0.03	26.2 J	32.6 J
	June 2004	0.70	3.3 J	10 U	3.3	3.3	0.16	24.4	9.55	0.03	25.6	37.6
	June 2009	0.64	8.1 U	8.1 U	17 U	2.91	0.106	19.2 J	7.12	0.030 J	20.8 J	29.3 J
TF-21	April 1996	0.92	42	4 J	46	4	0.2 U	23	9	0.05 U	19	30
	June 2000	N/A	32	10 U	32	5.5	0.16	34.5	14.1	0.06	27.7 J	51.2 J
	June 2004	2.42	1.16 [e]	0.41 U [e]	1.16 [e]	7	0.21	38.3	19.4	0.07	30.6	70.2
	June 2009	0.92	6.2 J	11 U	6.2 J	4.05	0.13	23.1 J	8.88	0.041 J	22.6	47.7
FLD-004[b]	June 2000	N/A	28	10 U	28	5.9	0.19	36.2	14.6	0.06	29.5 J	53 J

Table 6-5 (Continued)
Summary of Analytical Results for PCBs and Metals in OU 1 Sediment
From April 1996 Through June 2009

[a]Sediment quality standards (SQS) for PCBs based on TOC-normalized values and for metals based on dry weight values.
[b]PCB-contaminated sediment was removed in October 1999. FLD-004 is a field duplicate of TF-21 in 2000.
[c]TOC was not measured in sediment samples collected in 2000. As a result, TOC values from the 1996 sampling event were used to normalize the 2000 data.
[d]If percent TOC is between 1 and 4.5, then PCB concentrations shown in these three columns are TOC-normalized (see footnote e) with units of mg/kg OC. To calculate TOC-normalized values, the concentration in µg/kg is divided by the decimal fraction TOC times 1,000 µg/kg per mg/kg. If the percent TOC is less than 1 or greater than 4.5, the PCB concentrations are not normalized and are in units of µg/kg.
[e]TOC-normalized data

Notes:
Bolded value exceeds or is equal to the screening level. Shaded rows indicate the most current sampling period results.
Data from 1996 to 2004 are from U.S. Navy 2005a, with the exception of the TOC data and the TOC-normalized data for PCBs, which are from U.S. Navy 1996d (vol. II), 2003c, and 2005c, and data from 2009 are from U.S. Navy 2009h.
AET - apparent effects threshold
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
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram
mg/kg OC - milligram per kilogram of organic carbon
MRL - method reporting limit
NA - not applicable
N/A - not analyzed
PCBs - polychlorinated biphenyls
SQS - sediment quality standards
TOC - total organic carbon
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-6
Summary of Analytical Results for OU 1 Shellfish Tissue Sampling From 1996 to 2009

Location	Sampling Date	PCBs	Metals (mg/kg wet weight)						
		Aroclor 1254 (µg/kg wet weight)	Arsenic	Beryllium	Chromium	Lead	Mercury	Nickel	Zinc
DB-05	April 1996	5 J	3.1	0.004 U	0.74	0.128 J	0.03	0.92	9.6
	June 2000	10 U	2.23	0.003 U	0.38	0.12	0.02	0.64	13.86
	June 2004	10 U	2.11	0.003 U	0.15	0.1	0.02	0.63	12.09
	June 2009	9.8 U	1.740 J	0.0026 J	0.194	0.169 J	0.0147	0.324 J	11.9 J
DB-07	April 1996	3 U	3.6	0.004 U	0.76	0.116 J	0.03	0.75	9.7
	June 2000	10 U	2.26	0.003 UJ	0.48	0.42	0.01	0.37 J	16.5
	June 2004	10 U	1.98	0.003 UJ	0.11	0.12	0.01 U	0.52	14.15
	June 2009	9.7 U	1.450 J	0.0003 J	0.093	0.0796 J	0.0103	0.207 J	11.3 J
DB-07 FD	June 2000	10 U	2.22	0.003 UJ	1	0.33	0.01	0.59 J	19.50 J
DB-08	April 1996	3 U	4.1	0.004 U	0.68	0.138 J	0.02	1.01	10.1
	June 2000	10 U	2.14	0.003 UJ	0.65	0.11	0.01	0.50 J	19.42
	June 2004	10 U	2.92	0.003 UJ	0.13	0.07	0.02	0.78	12.94
	June 2009	9.9 U	1.970 J	0.0010 J	0.214	0.184 J	0.0169	0.263 J	13.5 J
DB-08 FD	June 2004	10 U	2.69	0.001 UJ	0.15	0.08	0.02	0.88	12.89
TF-18	April 1996	3 U	2.65	0.004 U	0.52	0.114 J	0.02	0.63	9
	June 2000	10 U	1.88	0.003 UJ	1.05	0.09	0.02	1.05 J	15.66
	June 2004	10 U	2.59	0.003 UJ	0.12	0.12	0.02	0.77	15.01
	June 2009	9.7 U	1.660 J	0.0006 J	0.119 J	0.0811 J	0.0183	0.274 J	10.9 J
TF-20	April 1996	3 U	3	0.004 U	0.83	0.109 J	0.02	0.81	9.4
	June 2000	10 U	1.88	0.003 UJ	0.72	0.09	0.02	0.93 J	15
	June 2004	10 U	2.04	0.003 UJ	0.08 U	0.1	0.02	0.72	14.21
	June 2009	10 U	1.760 J	0.0009 J	0.535	0.0802 J	0.024	0.270 J	8.490 J
TF-20 FD	June 2009	9.8 U	1.930 J	0.0065	1.23	0.365 J	0.0212	1.140 J	9.740 J
TF-21	April 1996	13	3.52	0.002 J	0.79	0.177 J	0.02	1.42	9.6
	June 2000	**23**	2.15	0.003 UJ	0.86	0.14	0.02	1.04 J	14.08
	June 2004	10 U	2.46	0.003 UJ	0.11	0.17	0.02	0.66	12.48
	June 2009	9.9 U	1.840 J	0.0023 J	0.13	0.127 J	0.0142	0.457 J	10.1 J
TF-21 FD	April 1996	11	2.5	0.004 U	0.63	0.189 J	0.02	1.14	9.1

Notes:
The remediation goal for total PCBs is 15 µg/kg for the seafood ingestion pathway and 2,600 µg/kg for the ecological risk pathway. Field duplicate data from 1996 to 2004 are from U.S. Navy 1996d and 2005c. All other data from 1996 to 2004 are from U.S. Navy 2005a, and data from 2009 are from U.S. Navy 2009h.
Bolded value indicates it exceeds or is equal to the remediation goal. Shaded rows indicate the most current sampling period results.
FD - field duplicate
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
mg/kg - milligram per kilogram
µg/kg - microgram per kilogram
MRL - method reporting limit
PCBs - polychlorinated biphenyls
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-7
Summary of Target Analytes Detected in Groundwater at OU 2 Area 2 From Fall 1995 to Spring 2009

Location	Sampling Date	cis,1,2-DCE (µg/L)	TCE (µg/L)	Vinyl Chloride (µg/L)
RG (Drinking Water)[a]		70[e]	5[f]	1[g]
2MW-1	11/01/95	1 U	**40**	**1 U**
	09/30/96	1 U	**28**	**1 U**
	10/16/97	1 U	**27**	**1 U**
	10/08/98	0.2 U	**28**	0.2 U
	11/22/99	0.5 U	**17**	0.5 U
	11/17/00	0.5 U	**22**	0.5 U
	11/19/01	0.1 U	**16**	0.2 U
	06/17/02	0.5 U	**11**	0.5 U
	06/18/03	0.5 U	**12**	0.5 U
	06/15/04	0.5 U	**9.7**	0.5 U
	06/21/05	0.2 U	**10**	0.2 U
	06/20/06	0.5 U	**8.1**	0.2 U
	06/12/07	0.5 U	**5.8**	0.2 U
	05/06/08	0.5 U	4.9	0.2 U
	06/24/09	0.21 J	**5.8 J**	0.2 U
2MW-3	11/01/95	19	1 J	**4**
2MW-4	11/01/95	1 U	1 U	**1 U**
2MW-5	11/01/95	7	**11**	**1**
	09/30/96	1	2	**1**
	10/16/97	1	2	**1**
	10/08/98	0.26	2.1	0.2
	11/22/99	0.5	0.4 J	0.5
2MW-6[b]	11/01/95	10	1 U	**4**
	09/30/96	15	1 U	**5**
	10/16/97	11	1 U	**4**
	10/08/98	9.5	0.2 U	**2.7**
	11/22/99	12	0.5 U	**2.7**
	11/17/00	14	0.5 U	**2.75 J**
	11/19/01	6.9 J	0.2 UJ	**1.15 J**
	06/17/02	13	0.5 U	**2.1**
	06/18/03	9.9	0.5 U	**1.5**
	06/15/04	6.9	0.5 U	0.86
	6/21/2005	4.5	0.2 U	0.68

Table 6-7 (Continued)
Summary of Target Analytes Detected in Groundwater at OU 2 Area 2 From Fall 1995 to Spring 2009

Location	Sampling Date	cis,1,2-DCE (µg/L)	TCE (µg/L)	Vinyl Chloride (µg/L)
2MW-6[b] (cont.)	6/21/2006	9	0.5 U	**1.1**
	6/13/2007	8.4	0.5 U	0.99
	5/7/2008	2.7	0.5 U	0.34
	06/24/09	7.1	0.03 J	0.99
MW2-6[c]	11/17/00	0.5 U	0.5 U	0.5 U
MW2-8[d]	11/19/01	0.72	0.2 U	0.2 U
	06/17/02	0.97	0.5 U	0.5 U
	06/18/03	1.4	0.5 U	0.5 U
	06/15/04	1.9	0.5 U	0.2 J
	06/24/05	1.9	0.2 U	0.2 U
	06/20/06	2	0.5 U	0.2 U
	06/12/07	1.9	0.5 U	0.2
	05/06/08	1.4	0.5 U	0.07 J
	06/24/09	1.1	0.5 U	0.07 J

[a]Protection of human health by ingestion
[b]The 11/17/00 and 11/19/01 results for 2MW-6 are the average concentrations of the 2MW-6 sample and its field duplicate.
[c]Prior to 2000, MW2-6 was last sampled in 1991 during the remedial investigation. Trichloroethene was detected at 0.6 (J) µg/L.
[d]The 06/17/02 results for MW2-8 are the average concentrations of the MW2-8 sample and its field duplicate.
[e]No RG for cis-1,2-DCE was established in the Record of Decision. For comparison purposes, the RG established for Area 8 is shown here.
[f]Value listed accounts for adjustment when the maximum contaminant level or water quality standard is sufficiently protective to serve as the Washington State Model Toxics Control Act (MTCA) cleanup level for that individual chemical. Individual chemical cleanup levels may require downward adjustment for multiple chemical contaminants or multiple exposure pathways (MTCA Implementation Memo No. 1). Value does not account for adjustments due to background levels or practical laboratory quantitation limits.
[g]The MTCA Method B cleanup level for vinyl chloride is 0.023 µg/L. This cleanup level is below the practical quantitation limit (PQL) of standard EPA analytical methods for drinking water. In such cases, the MTCA cleanup standard was adjusted based on the PQL, as stipulated in WAC 173-340-700(6). The PQL for U.S. Environmental Protection Agency Method 524.2 with a 25 ml purge is 1 µg/L.

Notes:
Bolded value indicates it exceeds or is equal to the RG for drinking water. Shaded columns indicate the most current sampling period results.
Data from 1995 to 2004 are from U.S. Navy 2005a; data from 2005 to 2008 are from U.S. Navy 2008c; and data from 2009 are from U.S. Navy 2009f.
DCE - dichloroethene

Table 6-7 (Continued)
Summary of Target Analytes Detected in Groundwater at OU 2 Area 2 From Fall 1995 to Spring 2009

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
µg/L - microgram per liter
MRL - method reporting limit
TCE - trichloroethene
RG - remediation goal
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-8
Summary of 1,4-Dioxane Results in Groundwater at OU 2 Area 2 for June 2007

Location	Sampling Date	1,4-Dioxane (µg/L)
2MW-1	06/12/07	1.0 U
2MW-6	06/13/07	0.3 J
MW2-8	06/12/07	1.0 U

Notes:
There is no remedial goal established for 1,4-dioxane. The Model Toxics Control Act cleanup level is 4.0 µg/L.
Data are from U.S. Navy 2007d.
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
µg/L - microgram per liter
MRL - method reporting limit
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-9
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2009)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	cis-1,2-DCE	PCE	1,1,1-TCA	TCE
RG (Drinking Water)[a]		7[b]	70	5[b]	200	5[b]
RG (Surface Water)[a]		3.2[b,c]	--	8.9[b,c]	42,000	81[b,c]
MW8-8	11/95	1	2	**49**	23	**190**
	6/96	0.90 J	1	**34**	11	**110**
	9/96	1	2	**58**	19	**190**
	5/97	1 U	1	**15**	3	**68**
	10/97	0.60 U	1 U	**19**	9	**78**
	5/98	1 U	.9 J	**12**	3	**63**
	10/98	1 U	1 U	**30**	9	**76**
	5/99	**5 U**	5 U	**5 U**	5 U	**58**
	11/99	1	3.2	2	10	**150 H**
	6/00	1 J	4.5	**23**	6.6	**120**
	6/01	1.3	7.3	**20**	3.9	**84**
	6/02	1.1	7.3	**17**	3.9	**81**
	6/03	0.94	6.8	**12**	2.7	**81 D**
	6/04	1.1	8.5	**13**	2.9	**80 D**
	6/05	0.7	7.4	**11**	2	**64**
	6/06	0.68	7.6	**9.2**	2.2	**68 D**
	6/07	0.55	7.5	**7.7**	1.7	**53 D**
	5/08	0.41 J	6.6	**8.4**	1.6	**59**
	06/09	0.69	9.1	**5.6**	1.6	**66**
MW8-9	11/95	**50 U**	27 J	**50 U**	50 U	**1600**
	6/96	1 U	28	1 U	2	**800**
	9/96	1 U	28	0.40 J	2	**1000**
	5/97	1 U	34	0.30 J	2	**1600**
	10/97	1 U	1 U	1 U	1	**720**
	5/98	1 U	12	1 U	0.70 J	**370**
	10/98	1 U	34	1 U	3	**610**
	5/99	1 U	6	1 U	1 U	**84**
	11/99	0.50 U	30	0.60	1.4	**500**
	6/00	2.5 U	15	2.5 U	1 J	**170**
	6/01	0.24 U	18	0.26 J	0.44 J	**330**
	6/02	0.50 U	7.5	0.23 J	0.69	**60**
	6/03	0.50 U	1.3 U	0.50 U	0.23 J	**21**
	6/04	0.50 U	1.7	0.18 J	0.44 J	**25**
	6/05	0.2 U	0.2	0.2 U	0.2 U	4.1

Table 6-9 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2009)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	cis-1,2-DCE	PCE	1,1,1-TCA	TCE
MW8-9 (cont.)	6/06	0.50 U	0.42 J	0.20 J	0.28 J	3.9
	6/07	0.5 U	0.27 J	0.5 U	0.15 J	1.9
	5/08	0.5 U	0.23 J	0.16 J	0.14 J	1.7
	06/09	0.2 U	1.3	0.18 J	0.14 J	**20**
MW8-10	6/00	0.54	1.8	1.2	4.2	**22**
	6/02	0.24 J	2.4	0.84	0.74	**31**
MW8-11	11/95	**44**	1 U	1 U	**520**	**84**
	6/96	**47**	1 U	1 U	**460**	**84**
	9/96	**27**	0.30 J	1 U	**420**	**80**
	5/97	**42**	1 U	1 U	**500**	**63**
	10/97	**30**	2	1 U	**300**	**62**
	5/98	**33**	1 U	1 U	**200**	**61**
	10/98	**35**	1 U	1 U	**220**	**62**
	5/99	**8**	2 U	2 U	45	**27**
	11/99	**12**	0.50 U	0.50 U	64 H	**54 H**
	6/00	**12**	0.40 J	0.50 U	82 J	**41 J**
	6/01	**15**	0.38 J	0.27 J	91	**62**
	6/02	1.1	0.46 J	0.79	84	**92**
	6/03	**20**	0.47 J	0.6	80 D	**99 D**
	6/04	**25**	0.37 J	0.66	80	**110 D**
	6/05	**10**	0.2	0.5	33	**61**
	6/06	**10**	0.27 J	0.68	39	**99 D**
	6/07	**3.3**	0.29 J	0.81	21	**46 D**
	5/08	2.4	0.37 J	1.1	31	**53**
	06/09	1.6	0.38 J	1.2	22	**67**
MW8-12	11/95	**10**	1	**13**	140	**85**
	6/96	**14**	1 U	**5**	180	**63**
	9/96	**20**	2	**23**	**250**	**120**
	5/97	**6**	1	**12**	67	**120**
	10/97	**4**	1 U	**7**	41	**44**
	5/98	2	2	**10**	20	**46**
	10/98	1 U	1 U	**15**	22	**46**
	5/99	1 U	1 U	4 U	8	**25**
	11/99	0.9	2.1	**9.7**	14	**50 H**
	6/00	0.50 J	3	**16**	6.8	**54**
	6/01	0.67	4.8	**14**	6.5	**76**

Table 6-9 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2009)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	cis-1,2-DCE	PCE	1,1,1-TCA	TCE
MW8-12 (cont.)	6/02	0.50 U	4.5	**14**	5	**47**
	6/03	0.31 J	3.2	**9.8**	3.2	**36**
	6/04	0.34 J	3.1	**8.5**	4.1	**40**
	6/05	0.3	3.3	**8.8**	2.8	**34**
	6/06	0.28 J	2.5	**7.9**	2.5	**31**
	6/07	0.22 J	3.5	**6.8**	2	**37**
	5/08	0.15 J	2.4	**7.7**	1.8	**28**
	06/09	0.18 J	3.4	**11**	2.5	**52**
MW8-14	11/95	1 U	1 U	1 U	1 U	1 U
	6/96	1 U	1 U	1 U	1 U	1 U
	9/96	1 U	1 U	1 U	1 U	1 U
	5/97	1 U	1 U	1 U	1 U	1 U
	10/97	1 U	1 U	1 U	1 U	1 U
	5/98	1 U	1 U	1 U	1 U	1 U
	10/98	1 U	1 U	1 U	1 U	1 U
	5/99	1 U	1 U	1 U	1 U	1 U
	11/99	0.50 U	3.2	0.50 U	0.50 U	0.50 U
	6/00	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	6/01	0.12 U	0.12 U	0.11 U	0.84	0.12 U
	6/02	0.50 U	0.50 U	0.50 U	0.18 J	0.50 U
	6/03	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
	6/04	0.50 U	0.50 U	0.50 U	0.12 J	0.50 U
	6/05	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
	6/06	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
	6/07	0.5 U	0.5 U	0.5 U	0.5 U	0.23 J
	5/08	0.5 U	0.5 U	0.5 U	0.11 J	0.5 U
	06/09	0.2 U	0.5 U	0.5 U	0.1 J	0.5 U
MW8-16	11/95	1 U	2	0.60 J	2	**58**
	6/96	1 U	2	0.80 J	2	**72**
	9/96	1 U	3	0.80 J	2	**69**
	5/97	1 U	2	0.80 J	2	**57**
	10/97	1 U	1 U	0.60 J	2	**47**
	5/98	1 U	2	0.80 J	1	**61**
	10/98	1 U	3	1 U	1 U	**47**
	5/99	1 U	6	1 U	2	**40**
	11/99	0.50 U	5.3	0.80	1.7	**63**

Table 6-9 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2009)

Location	Sampling Date	Analyte Concentration (µg/L)				
		1,1-DCE	cis-1,2-DCE	PCE	1,1,1-TCA	TCE
MW8-16 (cont.)	6/00	0.59	16	0.70	1.1	**51**
	6/01	0.77	21	0.84	1.2	**74**
	6/02	0.67	30 U	0.99	0.83	**130**
	6/03	0.57	28	1.5	0.94	**190 D**
	6/04	0.61	**130 D**	0.75	0.59 J	**120 D**
	6/05	0.9	34	2.2	0.7	**350**
	6/06	0.64	**93 D**	1.1	0.33 J	**200 D**
	6/07	0.68	38	1.5	0.42 J	**430 D**
	5/08	0.65	67 D	1	0.18 J	**380 D**
	06/09	0.21	14	0.64	0.13 J	**140 D**
Seep A	6/96	**16**	7	3	88	68
	6/00	3.1	3.7	0.30 J	19	7.4
	6/01	1.4	1.3	0.31 J	11	3
	6/02	1.0	0.68	0.50 U	9.5	1.2
	6/03	0.50 U	0.50 U	0.24 J	1.6	0.36 J
	6/04	**13.0**	9.9	0.92	77	49
	6/05	0.2 U	0.2 U	0.3	2.2	0.3
	6/06	1.5 J	2 J	0.3 J	12 J	3.6 J
	6/07	0.42	0.85	0.31 J	2.8	2.4
	5/08	1.1	1.7	0.55	5.5	7.7
	06/09	1.5	1.9	0.39 J	5.7	6.4
Seep B	6/96	1 U	0.70 J	1 U	1	14
	6/00	0.50 U	0.50 U	0.50 U	0.30 J	2.2
	6/01	0.12 U	0.44 J	0.13 J	0.26 J	3.1
	6/02	0.50 U	0.52	0.12 J	0.15 J	5.4
	6/03	0.50 U	0.20 J	0.14 J	0.50 U	1.9
	6/04	0.50 U	0.23 J	0.39 J	0.80	0.61
	6/05	0.2 U	0.2 U	0.4	0.3	0.3
	6/06	0.5 U	0.18 J	0.22 J	0.12 J	0.48 J
	6/07	0.5 U	0.5 U	0.5 U	0.5 U	0.14 J
	5/08	0.5 U	0.12 J	0.17 J	0.1 J	0.41 J
	06/09	0.2 U	0.5 U	0.18 J	0.16 J	0.4 J

[a]Protection of human health for ingestion
[b]Value listed accounts for adjustment when the maximum contaminant level or water quality standard is sufficiently protective to serve as the RG goal for that individual chemical. Individual cleanup levels may require downward adjustment for multiple

Table 6-9 (Continued)
Summary of Selected Volatile Organic Compounds Detected in Groundwater and Seeps at OU 2 Area 8 (Fall 1995 to Spring 2009)

chemical contaminants or multiple exposure pathways. Value does not account for adjustments due to background levels or practical laboratory quantitation limits.
[c]Protection of human health for fish ingestion

Notes:
Bolded value indicates concentration in the monitoring well exceeds or is equal to the RG for drinking water or surface water, whichever is lower. Bolded value indicates concentration in the seep exceeds or is equal to the RG for surface water. Shaded columns indicate the most current sampling period results.
Data from 1995 to 2004 are from U.S. Navy 2005a; data from 2005 to 2008 are from U.S. Navy 2008e; and data from 2009 are from U.S. Navy 2009d.
-- - no value given
D - The reported result is from a dilution.
DCE - dichloroethene
H - Analytical result is from an analysis reported past the holding time.
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
µg/L - micrograms per liter
MRL - method reporting limit
PCE - tetrachloroethene
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-10
Summary of 1,4-Dioxane Results in Groundwater at OU 2 Area 8 for June 2007

Location	Sampling Date	1,4-Dioxane (µg/L)
MW8-8	06/11/07	0.70 J
MW8-9	06/11/07	1.0 U
MW8-11	06/11/07	39
MW8-12	06/11/07	1.1
MW8-14	06/11/07	1.0 U
MW8-16	06/12/07	1.0 U

Notes:
There is no remediation goal established for 1,4-dioxane.
Data are from U.S. Navy 2007e.
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
µg/L - microgram per liter
MRL - method reporting limit
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-11
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2009)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
RG Drinking Water) (µg/L		0.05[e]				5		50[c]		80		590		15		2		100		48		1.1		4,800		320	
RG Surface Water (µg/L)		0.14[a,e]				8		50[d]		50		2.5		5.8		0.025		7.9		1.2		1.6		77		1	
MW8-6	6/96	NA	NA	NA	**1.1 B**	NA	(-)	NA	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	54.8	(-)	NA
MW8-7	11/95	**3.3 +**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	(-)	NA	**0.11**	NA	(-)	NA	(-)	NA	NS	**2.4 +**	(-)	NA	(-)	NA
MW8-8	11/95	(-)	NA	NA	NA	(-)	NA	NA	NA	**390**	NA	**4.8 +**	NA	(-)	NA	(-)	NA	**12.8 +**	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA
	6/96	NA	NA	NA	**1.4 B**	NA	(-)	NA	NA	**380**	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	**1.2 BN**	NA	(-)	(-)	NA
	9/96	NA	NA	(-)	NA	NA	(-)	**330**	NA	**320**	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	**2.0 UN**	NA	NA	(-)	NA	**319**	NA	**350**	NA	2.0 U	NA	(-)	NA	**0.20 U**	NA	5.0 U	NA	**4.0 U**	NA	1.0 UN	NA	(-)	(-)	NA
	10/97	NA	NA	**0.50 UN**	NA	NA	(-)	NA	**372**	NA	NA	NA	2.3 B	NA	(-)	NA	**0.10 U**	NA	**11.0 U**	NA	**1.8 B**	NA	**1.8 UN**	NA	(-)	(-)	NA
	5/98	NA	NA	**0.50 U**	NA	NA	(-)	NA	**344**	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	4.0 U	NA	1.0 UN	NA	**1.2 U**	NA	(-)	(-)	NA
	10/98	NA	NA	**1.8 U**	NA	NA	(-)	NA	**322**	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	(-)	NA	1.0 UN	NA	**1.2 U**	NA	(-)	**10 U**	NA
	5/99	NA	NA	**1.7 U**	NA	NA	(-)	NA	**184 N**	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	3.5 BN	NA	**2.2 U**	NA	1.0 UN	NA	(-)	(-)	NA
	11/99	NA	NA	**5 U**	NA	NA	2.5	NA	**154**	NA	NA	NA	**10 U**	NA	2 U	NA	**0.2 U**	NA	**20 U**	NA	**10 U**	NA	**5 U**	NA	10 U	NA	0.01 U
	6/00	NA	NA	**0.20 J**	NA	NA	1.33	NA	**95.7**	NA	**102 J**	NA	0.46 J	NA	0.03	NA	**0.10 U**	NA	3.21 J	NA	0.907	NA	0.01 U	NA	3.1	NA	**10 U**
	6/01	NA	NA	**0.3 UJ**	NA	NA	0.58	NA	**71.4**	NA	NS	NA	0.29 J	NA	0.04 U	0.0022	NA	NA	1.5	NA	0.62	NA	0.005 U	NA	2 U	NA	NA
	6/02	NA	NA	**0.13 J**	NA	NA	0.83 J	NA	**191**	NA	NA	NA	0.40	NA	0.15 UJ	NA	**0.10 U**	NA	1.45	NA	0.47 J	NA	0.006 J	NA	0.8	NA	NA
	6/03	NA	NA	**0.43 J**	NA	NA	0.15	NA	**84.1 J**	NA	NA	NA	0.49	NA	0.04	NA	**0.10 U**	NA	0.76 J	NA	0.17	NA	0.005 B	NA	0.7	NA	NA
	6/04	NA	NA	**0.32 B**	NA	NA	0.2	NA	**111**	NA	NA	NA	0.45	NA	0.009 B	NA	**0.04 U**	NA	0.79	NA	0.489	NA	0.003 U	NA	1.45	NA	NA
	06/05	NA	NA	**0.44**	NA	NA	1.2	NA	**88.3**	NA	NA	NA	0.42	NA	0.1 U	NA	**0.1 U**	NA	2.8	NA	0.265	NA	0.01 U	NA	0.99	NA	NA
	06/06	NA	NA	**0.27 B**	NA	NA	0.334	NA	**88.6**	NA	NA	NA	0.369	NA	0.021 U	NA	**0.2 U**	NA	0.61 J	NA	0.284	NA	0.02 U	NA	1.02	NA	NA
	06/07	NA	NA	**0.26 J**	NA	NA	0.12	NA	**81.9**	NA	NA	NA	**5.1**	NA	0.24	NA	**0.2 U**	NA	0.69	NA	0.19	NA	0.02 U	NA	1	NA	NA
	05/08	NA	NA	**0.21 B**	NA	NA	0.124	NA	**96**	NA	NA	NA	0.496	NA	0.054 U	NA	**0.2 U**	NA	1.08	NA	0.182	NA	0.005 B	NA	0.77	NA	NA
	06/09	NA	NA	**0.21 J**	NA	NA	0.432	NA	43.8	NA	NA	NA	0.437	NA	0.020 U	NA	**0.2 U**	NA	1.05	NA	0.746 J	NA	0.009 J	NA	1.43	NA	NA
MW8-9	11/95	**3.0 NW**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	**3.6 W+**	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA
	6/96	NA	NA	NA	**2.6 B**	NA	(-)	NA	NA	**380**	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	(-)	(-)	NA
	9/96	NA	NA	**3.4 BW**	NA	NA	3.5 B	(-)	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	**3.2 NW**	NA	NA	(-)	NA	(-)	NA	(-)	NA	2.0 U	NA	(-)	NA	**0.20 UN**	NA	5.0 U	NA	**4.0 U**	NA	**134 N**	NA	(-)	(-)	NA
	10/97	NA	NA	**1.4 BNW**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.35**	NA	**11.0 U**	NA	1.0 U	NA	**1.8 UNW**	NA	(-)	(-)	NA
	5/98	NA	NA	**1.1 BW**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	7.0 B	NA	1.0 UN	NA	**6.0 U**	NA	(-)	(-)	NA
	10/98	NA	NA	**5.4 B**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.13 B**	NA	**38.2 B**	NA	**2.0 B**	NA	**6.0 UW**	NA	(-)	**10 U**	NA
	5/99	NA	NA	**2.0 B**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	**16.3 BN**	NA	**2.7 B**	NA	**10.0 UNW**	NA	(-)	(-)	NA
	11/99	NA	NA	**5 U**	NA	NA	**14**	NA	8	NA	NA	NA	**10 U**	NA	2U	NA	**0.2 U**	NA	**20 U**	NA	**10**	NA	**5 U**	NA	10 U	NA	0.01 U
	6/00	NA	NA	**0.80 J**	NA	NA	1.05	NA	9.8	NA	16 J	NA	0.95 J	NA	0.97	NA	**0.10 U**	NA	**8.57 J**	NA	**3.7**	NA	0.01 U	NA	8.6	NA	**10 U**
	6/01	NA	NA	**0.5 J**	NA	NA	1.13	NA	9.7	NA	NS	NA	0.78 J	NA	0.04 U	0.0036		NA	4.2	NA	**1.61**	NA	0.005 B	NA	3 U	NA	NA
	6/02	NA	NA	**0.43 J**	NA	NA	0.65 J	NA	6.43	NA	NA	NA	0.90	NA	0.049 UJ	NA	**0.10 U**	NA	4.97	NA	**1.44 J**	NA	0.003 J	NA	3.2	NA	NA
	6/03	NA	NA	**0.58 J**	NA	NA	0.98	NA	6.9 J	NA	NA	NA	1.38	NA	0.23	NA	**0.10 B**	NA	4.85 J	NA	**1.66**	NA	0.015 B	NA	4.9	NA	NA
	6/04	NA	NA	**0.42 B**	NA	NA	0.51	NA	7.09	NA	NA	NA	0.73	NA	0.52	NA	**0.05 U**	NA	3.91	NA	**1.3**	NA	0.003 U	NA	1.57	NA	NA
	06/05	NA	NA	**0.43**	NA	NA	0.904	NA	6.8	NA	NA	NA	0.75	NA	0.1 U	NA	**0.1 U**	NA	3.5	NA	0.68	NA	0.01 U	NA	2.17	NA	NA
	06/06	NA	NA	**0.49 B**	NA	NA	0.454	NA	6.87	NA	NA	NA	0.652	NA	0.02 U	NA	**0.2 U**	NA	2.57 J	NA	0.863	NA	0.02 U	NA	1.01	NA	NA
	06/07	NA	NA	**0.52 J**	NA	NA	0.3	NA	6.1	NA	NA	NA	**8.1**	NA	0.35	NA	**0.2 U**	NA	2.3	NA	0.48	NA	0.02 U	NA	1.3	NA	NA
	05/08	NA	NA	**0.69**	NA	NA	0.363	NA	6.38	NA	NA	NA	0.654	NA	0.026 U	NA	**0.2 U**	NA	2.25	NA	0.421	NA	0.004 B	NA	0.82	NA	NA
	06/09	NA	NA	**0.63 J**	NA	NA	0.59	NA	4.85	NA	NA	NA	0.659	NA	0.020 U	NA	**0.2 U**	NA	1.55	NA	0.263 J	NA	0.020 U	NA	0.59	NA	NA
MW8-11	11/95	**2.0 W+**	NA	NA	NA	**251**	NA	NA	NA	**950**	NA	**13.4 S**	NA	(-)	NA	**0.22**	NA	**51.3**	NA	**4.2**	NA	(-)	NA	**207**	NA	**24**	NA
	6/96	NA	NA	NA	**1.0 U**	NA	**444**	NA	NA	**800**	NA	NA	**18.9 B**	NA	NA	NA	NA	NA	**39.5 B**	NA	NA	NA	(-)	NA	**248**	**20**	NA
	9/96	NA	NA	**2.4 BW**	NA	NA	**262**	**626**	NA	**720**	NA	NA	**14.3 B**	NA	NA	NA	NA	NA	**42.3**	NA	(-)	NA	NA	NA	**166**	NA	NA
	5/97	NA	NA	**2.1 NW**	NA	NA	**210**	NA	**441**	NA	**610**	NA	**12.4**	NA	(-)	NA	**0.20 UN**	NA	**30.5**	NA	**7.0 N**	NA	**10.0 UW**	NA	**161**	(-)	NA
	10/97	NA	NA	**0.66 BNW**	NA	NA	**278**	NA	**377**	NA	NA	NA	**11.7 B**	NA	(-)	NA	**0.32**	NA	**40.0**	NA	**4.4 B**	NA	**9.0 UNW**	NA	**178**	(-)	NA
	5/98	NA	NA	**0.50 UW**	NA	NA	**320**	NA	**303**	NA	NA	NA	**12.5 B**	NA	(-)	NA	**0.10 U**	NA	**36.9 B**	NA	**5.2 BN**	NA	**6.0 U**	NA	**193**	(-)	NA

Table 6-11 (Continued)
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2009)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
	10/98	NA	NA	2.1 B	NA	NA	126 E	NA	459	NA	NA	NA	9.0 B	NA	(-)	NA	0.17 B	NA	16.2 B	NA	2.2 B	NA	1.2 UW	NA	50.9	11	NA
	5/99	NA	NA	2.6 B	NA	NA	33.5 N	NA	198	NA	NA	NA	5.3 B	NA	(-)	NA	0.10 B	NA	4.6 BN	NA	2.2 U	NA	10.0 UNW	NA	(-)	(-)	NA
	11/99	NA	NA	5 U	NA	NA	205	NA	201	NA	NA	NA	10 U	NA	2U	NA	0.2 U	NA	20 U	NA	10	NA	5 U	NA	89	NA	0.03 U
	6/00	NA	NA	0.80 J	NA	NA	106	NA	221	NA	227 J	NA	4.44 J	NA	0.16	NA	0.10 U	NA	10.2 J	NA	2.09	NA	0.04	NA	109	NA	10 U
	6/01	NA	NA	0.7 J	NA	NA	129	NA	429	NA	NS	NA	4.95 J	NA	0.062	0.0071		NA	13	NA	2.29	NA	0.038	NA	110	NA	NA
	6/02	NA	NA	0.52 J	NA	NA	420 J	NA	608	NA	NA	NA	4.90	NA	0.047 UJ	NA	0.10 U	NA	9.46	NA	3.87 J	NA	0.040 J	NA	221	NA	NA
	6/03	NA	NA	0.61 J	NA	NA	353	NA	302 J	NA	NA	NA	5.15	NA	0.02 U	NA	0.10 U	NA	9.10 J	NA	5.87	NA	0.041	NA	134	NA	NA
	6/04	NA	NA	0.57	NA	NA	357	NA	290	NA	NA	NA	5.29	NA	0.036	NA	0.08 U	NA	31.9	NA	6.45	NA	0.053	NA	157	NA	NA
	06/05	NA	NA	1.9	NA	NA	266	NA	230	NA	NA	NA	4.63	NA	0.1 U	NA	0.1 U	NA	24.4	NA	6	NA	0.05	NA	91	NA	NA
	06/06	NA	NA	0.61	NA	NA	338	NA	157	NA	NA	NA	3.48	NA	0.066 U	NA	0.2 U	NA	25.8 J	NA	6.17	NA	0.0405	NA	135	NA	NA
	06/07	NA	NA	0.53 J	NA	NA	231	NA	150	NA	NA	NA	3.60	NA	0.094	NA	0.2 U	NA	19.3	NA	4.70	NA	0.038	NA	81.0	NA	NA
	05/08	NA	NA	0.82	NA	NA	154	NA	191	NA	NA	NA	3.44	NA	0.055 U	NA	0.2 U	NA	15.1	NA	3.5	NA	0.025	NA	58.1	NA	NA
	06/09	NA	NA	0.94 J	NA	NA	115	NA	163	NA	NA	NA	3.1	NA	0.020 U	NA	0.2 U	NA	11.1	NA	2.45 J	NA	0.024	NA	49.1	NA	NA
MW8-12	11/95	5.1 N	NA	NA	NA	28.6	NA	NA	NA	1500	NA	329 S+	NA	11.7	NA	0.19	NA	34.6 +	NA	(-)	NA	(-)	NA	(-)	NA	47	NA
	6/96	NA	NA	NA	3.6 B	NA	46.1	NA	NA	380	NA	NA	(-)	NA	NA	NA	NA	NA	17.9 B	NA	NA	NA	(-)	NA	29.7	31	NA
	9/96	NA	NA	1.9 B	NA	NA	53.8	1740	NA	1800	NA	NA	(-)	NA	NA	NA	NA	NA	49.3	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	2.0 UN	NA	NA	565	NA	1280	NA	1400	NA	64.4	NA	20 UN	NA	0.20 UN	NA	673	NA	40 UN	NA	1.0 UNW	NA	727	(-)	NA
	10/97	NA	NA	1.8 BN	NA	NA	154	NA	961	NA	NA	NA	150	NA	(-)	NA	0.10 U	NA	423	NA	1.8 B	NA	1.8 UNW	NA	325	(-)	NA
	5/98	NA	NA	2.4 BW	NA	NA	7.3	NA	728	NA	NA	NA	5.2 B	NA	(-)	NA	0.10 U	NA	7.5 B	NA	1.0 BN	NA	1.2 U	NA	(-)	(-)	NA
	10/98	NA	NA	1.8 U	NA	NA	6.5 E	NA	1090	NA	NA	NA	4.0 B	NA	(-)	NA	0.15 B	NA	8.9 B	NA	1.2 B	NA	1.2 U	NA	(-)	58	NA
	5/99	NA	NA	1.7 U	NA	NA	45.7 N	NA	815 N	NA	NA	NA	19.9 B	NA	3.2 N	NA	0.10 U	NA	70.0 N	NA	2.2 U	NA	1.0 UNW	NA	48.9	(-)	NA
	11/99	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6/00	NA	NA	0.20 J	NA	NA	20	NA	163	NA	216 J	NA	5.65 J	NA	0.75	NA	0.10 U	NA	26.8 J	NA	0.88	NA	0.01 U	NA	24.9	NA	10 U
	6/01	NA	NA	0.3 J	NA	NA	20.7	NA	193	NA	NA	NA	6.14 J	NA	1.2	0.0022	NA	NA	22	NA	1.24	NA	0.013 B	NA	25.3	NA	NA
	6/02	NA	NA	0.37 J	NA	NA	4.42 J	NA	238	NA	NA	NA	4.10	NA	0.17 UJ	NA	0.10 U	NA	2.77	NA	0.27 K	NA	0.006 J	NA	1.8	NA	0.06
	6/03	NA	NA	0.32 J	NA	NA	7.84	NA	107 J	NA	NA	NA	2.78	NA	0.15	NA	0.10 U	NA	4.36 J	NA	0.47	NA	0.013 B	NA	2.3	NA	NA
	6/04	NA	NA	0.43 B	NA	NA	3.23	NA	146	NA	NA	NA	5.15	NA	0.096	NA	0.05 U	NA	2.55	NA	-0.197	NA	0.007 B	NA	0.92	NA	NA
	06/05	NA	NA	1.3	NA	NA	2.04	NA	114	NA	NA	NA	3.7	NA	0.219	NA	0.1 U	NA	3	NA	0.22	NA	0.01 U	NA	5.97	NA	NA
	06/06	NA	NA	0.28 B	NA	NA	2.71	NA	113	NA	NA	NA	2.67	NA	0.048 U	NA	0.2 U	NA	1.99 J	NA	0.279	NA	0.02 U	NA	4.17	NA	NA
	06/07	NA	NA	0.47 J	NA	NA	0.31	NA	101	NA	NA	NA	2.6	NA	0.054	NA	0.2 U	NA	0.92	NA	0.037	NA	0.02 U	NA	0.67	NA	NA
	05/08	NA	NA	0.53	NA	NA	0.431	NA	100	NA	NA	NA	2.18	NA	0.036 U	NA	0.2 U	NA	1.07	NA	0.057	NA	0.004 B	NA	0.25 B	NA	NA
	06/09	NA	NA	0.68 J	NA	NA	0.109	NA	80.8	NA	NA	NA	1.65	NA	0.018 J	NA	0.2 U	NA	0.57	NA	0.016 J	NA	0.006 J	NA	0.15 J	NA	NA
MW8-14	11/95	5.1 W+	NA	NA	NA	22.4	NA	NA	NA	90	NA	152 S	NA	203 N	NA	0.52	NA	100	NA	(-)	NA	(-)	NA	241	NA	(-)	NA
	6/96	NA	NA	NA	3.3 B	NA	10.9	NA	NA	(-)	NA	NA	6.7 B	NA	NA	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	29.9	(-)	NA
	9/96	NA	NA	3.1 BW	NA	NA	19.9	(-)	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	8.6 B	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	2.8 NW	NA	NA	9.8	NA	(-)	NA	(-)	NA	2.0 U	NA	(-)	NA	0.20 UN	NA	5.0 U	NA	7.3 N	NA	10.0 UN	NA	(-)	(-)	NA
	10/97	NA	NA	1.0 BNW	NA	NA	3.2	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.48	NA	11.0 U	NA	2.0 B	NA	1.8 UBN	NA	(-)	(-)	NA
	5/98	NA	NA	0.86 BW	NA	NA	12.6	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.10 U	NA	4.8 B	NA	1.2 BN	NA	6.0 U	NA	(-)	(-)	NA
	10/98	NA	NA	10.8	NA	NA	16.9 E	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	0.15 B	NA	4 B	NA	1.0 U	NA	6.0 UW	NA	(-)	10 U	NA
	5/99	NA	NA	2.2 B	NA	NA	10.5 N	NA	(-)	NA	NA	NA	13.2	NA	(-)	NA	0.10 U	NA	(-)	NA	2.2 U	NA	10.0 UNW	NA	(-)	(-)	NA
	11/99	NA	NA	5 U	NA	NA	13	NA	7	NA	NA	NA	10 U	NA	2U	NA	0.2U	NA	20 U	NA	10 U	NA	5 U	NA	10 U	NA	0.01 U
	6/00	NA	NA	2	NA	NA	13.8	NA	14.4	NA	58.8 J	NA	1.22 J	NA	0.61	NA	0.10 U	NA	3.71 J	NA	0.564	NA	0.01 U	NA	3.2	NA	10 U
	6/01	NA	NA	1.3 J	NA	NA	13.2	NA	29.7	NA	NA	NA	1.16 J	NA	0.959	.0009 B		NA	2.4	NA	0.31	NA	0.007 B	NA	3 U	NA	NA
	6/02	NA	NA	1.53 J	NA	NA	14.9 J	NA	15.8	NA	NA	NA	1.70	NA	0.74 UJ	NA	0.10 U	NA	4.63	NA	0.44 J	NA	0.007 J	NA	4	NA	NA
	6/03	NA	NA	2.08 J	NA	NA	14.6	NA	16.2 J	NA	NA	NA	1.53	NA	0.74	NA	0.10 U	NA	4.71 J	NA	0.38	NA	0.006 B	NA	2.6	NA	NA
	6/04	NA	NA	1.63	NA	NA	13.5	NA	22.2	NA	NA	NA	1.37	NA	0.89	NA	0.06 U	NA	5.61	NA	0.351	NA	0.007 B	NA	2.6	NA	NA
	06/05	NA	NA	2	NA	NA	12.5	NA	17.8	NA	NA	NA	1.65	NA	1.1	NA	0.1 U	NA	6.9	NA	0.46	NA	0.01 U	NA	2.92	NA	NA
	06/06	NA	NA	1.66	NA	NA	11.1	NA	14.9	NA	NA	NA	1.13	NA	0.682	NA	0.2 U	NA	5.17 J	NA	0.358	NA	0.02 U	NA	2.25	NA	NA

Table 6-11 (Continued)
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2009)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
	06/07	NA	NA	**1.5 J**	NA	NA	**9.8**	NA	15.4	NA	NA	NA	**2.9**	NA	0.99	NA	**0.2 U**	NA	5.5	NA	0.33	NA	0.02 U	NA	2.6	NA	NA
	05/08	NA	NA	**1.91**	NA	NA	**8.33**	NA	21	NA	NA	NA	1.38	NA	0.817	NA	**0.2 U**	NA	5.21	NA	0.24	NA	0.012 B	NA	2.2	NA	NA
	06/09	NA	NA	**1.78 J**	NA	NA	**8.91**	NA	18.2	NA	NA	NA	1.76	NA	1.18	NA	**0.2 U**	NA	5.08	NA	0.259 J	NA	0.005 J	NA	2.58	NA	NA
MW8-15	11/95	(-)	NA	**1.0 UN**	NA	(-)	(-)	NA	NA	(-)	NA	**2.5 +**	(-)	(-)	(-)	(-)	NA	(-)	**9.3 +**	(-)	**3.0 UNW**	NS	(-)	(-)	35.6	(-)	NA
MW8-16	11/95	**2.3 +**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	(-)	NA	**0.16**	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA	(-)	NA
	6/96	NA	NA	NA	**2.8 B**	NA	(-)	NA	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	NA	NA	**1.1 BNW**	NA	(-)	(-)	NA
	9/96	NA	NA	**2.9 B**	NA	NA	(-)	(-)	NA	(-)	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	NA
	5/97	NA	NA	**2.3 N**	NA	NA	(-)	NA	(-)	NA	(-)	NA	2.0 U	NA	(-)	NA	**0.20 UN**	NA	5.0 U	NA	**4.0 UN**	NA	1.0 UNW	NA	(-)	(-)	NA
	10/97	NA	NA	**1.4 BN**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	**11.0 U**	NA	1.0 U	NA	**1.8 UN**	NA	(-)	(-)	NA
	5/98	NA	NA	**1.2 B**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	5.7 B	NA	1.0 UN	NA	**1.2 U**	NA	(-)	(-)	NA
	10/98	NA	NA	**1.8 U**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	(-)	NA	**0.10 U**	NA	(-)	NA	1.0 U	NA	**1.2 U**	NA	(-)	**10 U**	NA
	5/99	NA	NA	**1.7 U**	NA	NA	(-)	NA	(-)	NA	NA	NA	(-)	NA	3.4 N	NA	**0.11 B**	NA	4,1 BN	NA	**2.2 U**	NA	1.0 UNW	NA	(-)	(-)	NA
	11/99	NA	NA	**5 U**	NA	NA	4 U	NA	5U	NA	NA	NA	**10 U**	NA	2 U	NA	**0.2 U**	NA	**20 U**	NA	**10 U**	NA	**5 U**	NA	10 U	NA	0.01 U
	6/00	NA	NA	**1.14 J**	NA	NA	0.16	NA	.17 U	NA	4.0 U	NA	0.20 J	NA	**7 U**	NA	**0.10 U**	NA	1.02 J	NA	0.020 B	NA	0.03 U	NA	4	NA	**10 UJ**
	6/01	NA	NA	**1.5 J**	NA	NA	0.21	NA	0.45	NA	NA	NA	0.2 R	NA	0.04 U	.0003 B	NA	NA	1.4	NA	0.07 U	NA	0.005 U	NA	36.5	NA	NA
	6/02	NA	NA	**1.82 J**	NA	NA	0.065 J	NA	0.04 U	NA	NA	NA	0.20	NA	0.011 UJ	NA	**0.10 U**	NA	2.59	NA	0.001 J	NA	0.002 J	NA	1.7	NA	NA
	6/03	NA	NA	**2.37 J**	NA	NA	0.42	NA	1.0 UJ	NA	NA	NA	0.10 U	NA	0.10 U	NA	**0.10 U**	NA	**9.34 J**	NA	0.04 U	NA	0.02 U	NA	2.3 B	NA	NA
	6/04	NA	NA	**2.75**	NA	NA	0.055	NA	0.04 U	NA	NA	NA	0.38	NA	0.011 B	NA	**0.04 U**	NA	3.76	NA	0.005 U	NA	0.001 U	NA	1.07	NA	NA
	06/05	NA	NA	**3**	NA	NA	2 U	NA	5 U	NA	NA	NA	2	NA	2 U	NA	**0.1 U**	NA	**10 U**	NA	**3 U**	NA	1 U	NA	6 U	NA	NA
	06/06	NA	NA	**2.44**	NA	NA	0.186	NA	0.2 U	NA	NA	NA	0.043 B	NA	0.02 U	NA	**0.2 U**	NA	3.61 J	NA	0.028	NA	0.02 U	NA	1.15	NA	NA
	06/07	NA	NA	**2.3 J**	NA	NA	0.098	NA	1	NA	NA	NA	0.77	NA	0.075	NA	**0.2 U**	NA	2.7	NA	0.02 U	NA	0.02 U	NA	1	NA	NA
	05/08	NA	NA	**3.61**	NA	NA	0.125	NA	0.41	NA	NA	NA	0.043 B	NA	0.044 U	NA	**0.2 U**	NA	0.64	NA	0.01 B	NA	0.002 U	NA	0.36 B	NA	NA
	06/09	NA	NA	**3.50 J**	NA	NA	0.013 J	NA	0.10 J	NA	NA	NA	0.156	NA	0.020 U	NA	**0.2 U**	NA	0.42	NA	0.004 J	NA	0.02 U	NA	0.10 J	NA	NA
MW8-17	11/95	**3.0 N**	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	**26.7 S+**	NA	(-)	NA	**0.11**	NA	**35.2 +**	NA	(-)	NA	NA	(-)	(-)	NA	(-)	NA
MW8-18	11/95	**1.8 N**	NA	**1.2 N**	NA	(-)	(-)	NA	NA	(-)	NA	**3.8 +**	(-)	(-)	(-)	(-)	NA	**16.0 +**	**9.0 +**	(-)	**3.0 UNW**	NA	(-)	(-)	(-)	(-)	NA
MW8-19	11/95	**3.3 NW**	NA	**1.9 N**	NA	(-)	(-)	NA	NA	(-)	NA	**22.9 S+**	1.3 +	3.2	NA	(-)	NA	**25.7 +**	**9.0 U +**	(-)	**3.0 UNW**	NA	(-)	(-)	(-)	(-)	NA
MW8-20	11/95	(-)	NA	NA	NA	(-)	NA	NA	NA	(-)	NA	**7.9 +**	NA	(-)	NA	(-)	NA	**18.6 +**	NA	(-)	NA	NA	(-)	(-)	NA	(-)	NA
Seep A	6/96	NA	NA	NA	**1.3 B**	**46.7**	**33.9**	NA	NA	**240**	NA	**7.8 B**	**5.1 B**	NA	NA	NA	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	(-)	NA
	5/97	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	(-)	NA	NA	NA	NA
	6/00	NA	NA	**2.4 J**	NA	NA	0.14	NA	0.6	NA	NA	NA	0.27	NA	1.3 J	NA	NA	NA	5.59 J	NA	1.14 J	NA	0.02	NA	0.8	NA	**10 U**
	6/01	NA	NA	**0.9 J**	NA	NA	**23.2**	NA	5.6	NA	NA	NA	1 J	NA	0.06	0.0034	NA	NA	1	NA	0.1	NA	0.022	NA	7.6 B	NA	NA
	6/02	NA	NA	**1.95 J**	NA	NA	2.57 J	NA	0.44 U	NA	NA	NA	0.80	NA	0.054 UJ	NA	**0.10 U**	NA	0.95	NA	0.011 UJ	NA	0.003 J	NA	1.3	NA	NA
	6/03	NA	NA	**1.29 J**	NA	NA	**38.3**	NA	7.6 J	NA	NA	NA	0.89	NA	0.03	NA	**0.10 U**	NA	1.22 J	NA	0.02	NA	0.012 B	NA	4.5 B	NA	NA
	6/04	NA	NA	**0.66**	NA	NA	**88.9**	NA	45.5	NA	NA	NA	1.08	NA	0.032	NA	**0.06 U**	NA	4.29	NA	0.031	NA	0.015 B	NA	0.83	NA	NA
	06/05	NA	NA	**1.7**	NA	NA	**50.3**	NA	11	NA	NA	NA	1.13	NA	0.1 U	NA	**0.1 U**	NA	2	NA	0.032 U	NA	0.014	NA	1.83	NA	NA
	06/06	NA	NA	**1.21**	NA	NA	**14.4**	NA	3.58	NA	NA	NA	0.814	NA	0.08 U	NA	**0.2 U**	NA	1.74 J	NA	0.162	NA	0.02 U	NA	1.4	NA	NA
	06/07	NA	NA	**1 J**	NA	NA	**19.4**	NA	7.2	NA	NA	NA	1.2	NA	0.063	NA	**0.2 U**	NA	1.5	NA	0.02 U	NA	0.02 U	NA	1.5	NA	NA
	05/08	NA	NA	**2.48**	NA	NA	7.96	NA	10.6	NA	NA	NA	0.867	NA	0.092 U	NA	**0.2 U**	NA	1.77	NA	0.037	NA	0.01 B	NA	1.44	NA	NA
	06/09	NA	NA	**1.50 J**	NA	NA	2.57	NA	5.0	NA	NA	NA	0.383	NA	0.028	NA	**0.2 U**	NA	1.18	NA	0.013 J	NA	0.003 J	NA	1.00	NA	NA
Seep B	6/96	NA	**3.0 B**	NA	**4.6 B**	(-)	(-)	NA	NA	(-)	NA	**24.5 B**	**8.5 B**	NA	NA	NA	NA	NA	(-)	NA	NA	NA	NA	NA	(-)	(-)	NA
	5/97	NA	NA	NA	NA	NA	NS	NA	NS	NA	NA	NA	NS	NA	NA	NA	NA	NA	NS	NA	NA	NA	(-)	NA	NA	NA	NA
	6/00	NA	NA	**2.5 J**	NA	NA	0.82	NA	6.4	NA	NA	NA	0.76	NA	.22 J	NA	NA	NA	.83 J	NA	0.297 J	NA	0.01 U	NA	1.4	NA	**10 U**
	6/01	NA	NA	**1.4 J**	NA	NA	1.52	NA	4.4	NA	NA	NA	0.8 J	NA	0.04 U	.0009 B	NA	NA	1	NA	0.1 U	NA	0.011 B	NA	3.4 U	NA	NA
	6/02	NA	NA	**1.29 J**	NA	NA	2.23 J	NA	3.54	NA	NA	NA	0.90	NA	0.024 UJ	NA	**0.10 U**	NA	1.95	NA	0.049 J	NA	0.011 J	NA	1.9	NA	NA
	6/03	NA	NA	**1.33 J**	NA	NA	4.18	NA	2.9 J	NA	NA	NA	0.76	NA	0.02 U	NA	**0.10 U**	NA	1.26 J	NA	0.09	NA	0.013 B	NA	9.0 B	NA	NA
	6/04	NA	NA	**1.02**	NA	NA	**8.33**	NA	15.9	NA	NA	NA	0.71	NA	0.27	NA	**0.06 U**	NA	4.31	NA	0.097	NA	0.017 B	NA	0.97	NA	NA
	06/05	NA	NA	**1.43**	NA	NA	2.06	NA	6.52	NA	NA	NA	0.89	NA	0.1 U	NA	**0.1 U**	NA	2.77	NA	0.035	NA	0.01 U	NA	1.12	NA	NA
	06/06	NA	NA	**1.32**	NA	NA	2.1	NA	3.33	NA	NA	NA	0.602	NA	0.022	NA	**0.2 U**	NA	2.64 J	NA	0.085	NA	0.02 U	NA	1.01	NA	NA

Table 6-11 (Continued)
Summary of Inorganics Detected in Groundwater and Seeps at OU 2 Area 8 Exceeding One-Half of the MTCA Method B Cleanup Levels (Fall 1995 to Spring 2009)

		Analyte Concentration (µg/L)																									
		Arsenic				Cadmium		Chromium		Chromium VI		Copper		Lead		Mercury		Nickel		Silver		Thallium		Zinc		Cyanide	
Location	Sampling Date	Total	Total (ICP)	Dissolved	Dissolved (ICP)	Total	Dissolved	Total	Dissolved[b]	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
	06/07	NA	NA	**1.1 J**	NA	NA	1.1	NA	2.7	NA	NA	NA	0.6	NA	0.058	NA	**0.2 U**	NA	1.8	NA	0.02 U	NA	0.02 U	NA	0.96	NA	NA
	05/08	NA	NA	**2.27**	NA	NA	1.26	NA	3.28	NA	NA	NA	0.668	NA	0.18 U	NA	**0.2 U**	NA	2.11	NA	0.051	NA	0.019 B	NA	1.39	NA	NA
	06/09	NA	NA	**1.26 J**	NA	NA	0.616	NA	3.19	NA	NA	NA	0.618	NA	0.058	NA	**0.2 U**	NA	1.10	NA	0.009 J	NA	0.004 J	NA	0.73	NA	NA

[a]Value listed is the lower of the cancer or noncancer value.
[b]Results for chromium are less than the results reported for chromium (VI) because of variation in analytical methods. Variance in results for these analytes is common.
[c]Value is for total chromium. Chromium (VI) is 80 µg/L.
[d]50 µg/L is for chromium (VI). There is no goal for total chromium.
[e]The background concentration of arsenic in groundwater at the site is 12 µg/L.

Notes:
Bolded value indicates concentration in the monitoring well exceeds or is equal to the RG for drinking water or surface water, whichever is lower. Bolded value indicates concentration in the seep exceeds or is equal to the RG for surface water. Shaded columns indicate the most current sampling period results.
Data from 1995 to 2004 are from U.S. Navy 2005a; data from 2005 to 2008 are from U.S. Navy 2008e; and data from 2009 are from U.S. Navy 2009d.
(-) - undetected above one-half of the MTCA Method B cleanup levels
+ - Duplicate analysis is not within control limits.
B - between instrument detection limit and contract required detection limit
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
µg/L - microgram per liter
MRL - method reporting limit
MTCA - Model Toxics Control Act
N - Spiked sample is outside of control limits.
NA - not analyzed
RG - remediation goal
S - determined by method of standard additions
W - Post-digestion spike for furnace atomic absorption spectrophotometric analysis is out of control limits (85% to 115%), and sample is less than 50% of spike absorbance.
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-12
Chemical Concentrations in OU 2 Area 8 Sediments (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Phenanthrene (µg/kg)	Phenol (µg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Sediment Quality Standard		160	100	420	5.1	260	390	450	0.41	NA	6.1	410
Cleanup Screening Level		1200	480	1200	6.7	270	390	530	0.59	NA	6.1	960
Background Screening Value[a]		NA	NA	NA	0.68	88	35	36	0.109	NA	<0.23	96
Remedial Investigation[b]												
LB17		110 J	**110**	210	0.45 J	120	18	12	0.018	NA	ND	55
LB18		ND	ND	**650**	ND	92	15	ND	0.02	NA	0.38 J	63
Seep Sediments												
S.STATION1	04-MAY-1996	110	14	**3000 J**	0.6	14.1 J	6.4 J	6.6 J	0.07	10.2	0.3 J	29.5 J
	01-JUN-2000	17	7 J	140	0.79 J	26.9	10.3	5.15	0.03	19.3 J	0.23	34.7 J
	03-JUN-2004	15	4.3 J	400	0.252 J	22	14.6 J	7.4	0.03	30.3	0.332	42.2
	29-JUL-2008	9.8 U	2.5 J	**670**	0.82 J	21.8	16	31.6 J	0.033 U	29.9	0.545 J	44.1 J
S.STATION2	04-MAY-1996	13	4.5 J	**1900**	2	34.9 J	16.5	3.1 J	**1.9 J**	15.8	0.8 J	39.1 J
	01-JUN-2000	28	5 J	20 J	3.96 J	45.4	10	4.64	**0.89**	20.2 J	0.33	38.4 J
	03-JUN-2004	7.8 J	1.6 U	30 U	4.49 J	38.3	20.8 J	8.88	0.09	31.3	0.301	94.8
	29-JUL-2008	11 U	3.5 J	18 J	2.2 J	22.9	12.5	5.9 J	0.037 U	21.1	0.189 J	47 J
S.STATION3	04-MAY-1996	19	12	110 J	**8.1**	166 J	12.5	5.5 J	0.2 J	28 J	0.8 J	42.7 J
	02-JUN-2000	82	53	62	4.87 J	97.7	12.9	7.33	0.26	25 J	0.26	44.5 J
	03-JUN-2004	56	**100**	410	**8.32 J**	62.1	13.9 J	5.44	**1.58**	30.9	0.732	45.8
	29-JUL-2008	14 U	2.2 J	160	**13.8 J**	34.8	13.7	5.22 J	0.197	23.8	0.395 J	47.1 J
Midzone Sediments												
S.STATION4	04-MAY-1996	9.1	3.5	240 J	4.8	46.4 J	10.6	6.5 J	0.06	29.5	0.6 J	47 J
	01-JUN-2000	65 J	9 J	300	1.38 J	36.3	9.37	5.93	0.06	20.4 J	0.72	30.5
	03-JUN-2004	5.4 J	7.5 J	75	1.9 J	26	13.6 J	6.32	0.02	31.6	0.251	39
	29-JUL-2008	9.8 U	3.4 J	**500**	0.946 J	18.3	12.1	4.78 J	0.04 U	20.5	0.316 J	39.2 J

Table 6-12 (Continued)
Chemical Concentrations in OU 2 Area 8 Sediments (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Phenanthrene (µg/kg)	Phenol (µg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
S.STATION5	04-MAY-1996	44	12	**530**	2	65.4 J	8.7	5.5 J	0.06	19.8	0.3 J	35.1 J
	02-JUN-2000	15	7 J	20 J	**6.23 J**	26.9	12.6	6.24	0.06	26.4 J	0.59	39.7 J
	03-JUN-2004	19	2.1 J	30 U	2.85 J	31.5	10.7 J	4.49	**0.46**	26.9	0.317	37.3
	29-JUL-2008	27	1.3 U	16 J	**10.2 J**	52.9	13.8	13.7 J	0.059	23.9	0.682	37.6 J
S.STATION6	04-MAY-1996	11	6 U	390 U	3.4	194 J	10.4	10.5 J	0.05	21.7	0.4 J	41.8 J
	02-JUN-2000	8 J	4 J	30 J	1.98 J	75.4	10.6	6.22	0.16	21.2 J	0.23	35.5 J
	03-JUN-2004	14	2.8 J	69	**9.13 J**	64.5	13.1 J	4.93	**0.72**	24.1	1.25	39.3
	29-JUL-2008	10 U	8.7	**710**	**7.27 J**	56.9	13	5.62 J	0.191	24.3	0.32 J	44.8 J
Deeper Sediments												
S.STATION7	04-MAY-1996	11	13	**460** U	0.07	54 J	10.5	7.8 J	0.07	24.8	0.07	46.8 J
	01-JUN-2000	16	4 J	79	0.22 J	19.5	7.74	5.59	0.04	17 J	0.09	27 J
	03-JUN-2004	13	2.8 J	**2000**	2.66 J	34.6	10.5 J	6.31	0.04	24.4	1.54	33.1
	29-JUL-2008	9.9 U	1.3 U	360	0.515 J	23.6	11	19.2 J	0.038 U	21.4	0.154 J	33.7 J
S.STATION8	04-MAY-1996	49	22	**5200**	0.2 J	48 J	7.4	4.4 J	0.06	14	0.2 J	27.3 J
	02-JUN-2000	6 J	10 U	**1500**	0.97 J	67.1	8.05	4.83	0.04	17.9 J	0.22	30.1 J
	03-JUN-2004	5.8 J	2 J	**1000**	**5.64 J**	43.9	11.5 J	4.88	0.07	21.9	0.42	31.8
	29-JUL-2008	10 U	2.5 J	**620**	**15 J**	36.8	15.4	3.92 J	0.038 U	25.4	0.456 J	38.4 J
S.STATION9	04-MAY-1996	59	22	240 J	0.5	83.7 J	11.3	7.4 J	0.05	20.7	0.3 J	38.3 J
	02-JUN-2000	48	23	**2000**	1.46 J	86.9	10.2	37.6	0.07	21 J	0.23	45 J
	03-JUN-2004	89	65	30 U	**6.44 J**	59.5	13 J	8.35	0.21	27.7	0.364	40.6
	29-JUL-2008	10	3.3 J	16 J	**21.9 J**	73.3	15	26.6 J	0.329	29.3	0.484 J	43.1 J
Mean[c,d]												
All Stations	1996	36	12	**1294**	2.4	79	10	6.4	0.28	21	0.42	38.62
	2000	32	13	**461**	2.4	54	10	9.3	0.18	21	0.32	36.16
	2004	25	21	**444**	4.6	42	14	6.3	0.36	28	0.61	44.88
	2008	8.3	3.0	341	**8.1**	38	14	12.9	0.097	24	0.39	41.67

Table 6-12 (Continued)
Chemical Concentrations in OU 2 Area 8 Sediments (1996 Through 2008)

[a]Background screening value: 95th percentile, maximum value, or minimum detection limit value of samples from reference locations (U.S. Navy 1993)
[b]Locations LB17 and LB18 from the remedial investigation (U.S. Navy 1993) were immediately offshore of Area 8 and are considered subtidal, whereas Area 8 sediment locations (i.e., 1 through 9) are intertidal. LB18 was located close to Pier 2, and sediments might be affected by pier-related activities. Thus, results of sediment sampling at these remedial investigation locations and the 1996 monitoring locations are likely not directly comparable.
[c]One-half detection limit was used to calculate the mean for all nondetects.
[d]Mean of sampling locations (1–9) for each year

Notes:
Bolded value indicates detected concentration exceeds the sediment quality standard. Shaded columns indicate the most current sampling period results.
Data presented in this table were downloaded from the Naval Installation Restoration Information Solution (NIRIS) database, when available in NIRIS. If not available in NIRIS, data were entered directly from the second 5-year review report (U.S. Navy 2005a).
Results are reported on a dry-weight basis.
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
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram
MRL - method reporting limit
NA - not available or not analyzed
ND - not detected
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

Table 6-13
Chemical Concentrations in OU 2 Area 8 Clam Tissue (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Pyrene (µg/kg)	Phenol (µg/kg)	Benzoic Acid (µg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Background Screening Value[a]		NA	NA	NA	NA	0.26	< 0.95	0.76	NA	0.01	< 0.58	0.35	NA
Remedial Investigation[b]													
LB17		660 U	660 UJ	660 U	1600 UJ	0.09	0.49	1	0.14 U	0.01	0.440	0.070	10.9 U
Seep Tissue													
STATION 1	04-MAY-1996	NA	NA	240	2600	1.5	2.84	1.82	0.21	0.03	1.2	2.2	14.1
	01-JUN-2000	8 J	6 J	50 U	4300	0.60 J	0.74	1.03 J	0.05 J	0.02	0.62 J	0.31	14.6
	03-JUN-2004	6.7 U	8.2 U	54 U	1300 J	0.57	0.43	1.1	0.057	0.02	0.86	0.9	12
	30-JUL-2008	1.9 J	4.8 U	87 U	1600 J	1.1	0.64	0.87	0.054	0.021	0.53	0.59	9.6
S.STATION2	07-MAY-1996	NA	NA	NA	2000	5.4	1.86	1.71	NA	0.18	0.5	0.73	16.5
	01-JUN-2000	8 J	10	20 J	6900	1.94 J	1.53	1.15 J	0.07 J	0.04	0.57 J	0.29	14.7
	03-JUN-2004	6.7 U	8.2 U	54 U	2100 J	1.2	0.63	1.2	0.065	0.022	0.87	0.58	16
	30-JUL-2008	1.9 J	4.8 U	96 U	1300 J	3.5	0.33	0.67	0.052	0.029	0.38	0.14	11
S.STATION3	07-MAY-1996	12 J	NA	NA	2400	5.75	8.78	1.73	0.12 J	0.02	0.6	0.31	17.5
	02-JUN-2000	7 J	25	50 U	6700	0.80 J	1.52	1.12	0.05 J	0.05	0.73 J	0.28	16.1
	03-JUN-2004	6.7 U	8.2 U	54 U	3700 J	1.8	1.1	1.17	0.074	0.039	0.81	0.57	15
	30-JUL-2008	1.6 J	4.8 U	91 U	1300 J	3.5	0.30	0.57	0.044 U	0.026	0.32	0.13	9.7
Midzone Tissue													
S.STATION4	07-MAY-1996	10	15 J	NA	1600	2.2	2.41	1.50	NA	0.02	0.6	0.81	13.6
	01-JUN-2000	10	6 J	20 J	6400	0.93 J	0.50	1.02 J	0.05 J	0.01	0.52 J	0.4	16.1
	03-JUN-2004	6.7 U	8.2 U	54 U	4500 J	1.3	0.77	1.01	0.063	0.02	0.82	0.83	13
	30-JUL-2008	2.1 J	1.2 J	92 U	1600 J	1.6	0.40	0.80	0.048	0.033	0.46	0.41	12
S.STATION5	04-MAY-1996	11	13 J	NA	2000 J	1.01	2.75	1.38	0.14 J	0.02	1.3	0.28	13.2
	02-JUN-2000	8 J	7 J	30 J	7300	1.21 J	0.67	0.96 J	0.05	0.02	0.43 J	0.17	14.2
	03-JUN-2004	6.7 U	8.2 U	54 U	5300 J	4.5	1.1	1.2	0.053	0.16	0.42	0.48	12
	30-JUL-2008	1.8 J	4.7 U	88 U	4000 J	0.97	0.22	0.72	0.069	0.021	0.41	0.13	11
S.STATION6	07-MAY-1996	NA	NA	NA	NA	1.5	2.57	1.11	NA	0.01	0.4	0.11	13.7
	02-JUN-2000	6 J	19	20 J	8500	0.54 J	0.44	1.09 J	0.04 J	0.02	0.41 J	0.13	18.5
	03-JUN-2004	6.7 U	8.2 U	54 U	5400 J	2.5	0.64	1.2	0.071	0.028	0.53	0.48	14
	30-JUL-2008	2 J	1.2 J	89 U	3000 J	0.87	0.19	0.92	0.072	0.023	0.38	0.18	11

Table 6-13 (Continued)
Chemical Concentrations in OU 2 Area 8 Clam Tissue (1996 Through 2008)

Location	Sampling Date	Fluoranthene (µg/kg)	Pyrene (µg/kg)	Phenol (µg/kg)	Benzoic Acid (µg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Deeper Tissue													
S.STATION7	07-MAY-1996	20	18 J	NA	1900 J	0.25	0.39	1.66	NA	0.01	0.4	0.43	15
	01-JUN-2000	11	29	30 J	10000	0.19 J	0.6	1.50 J	0.06 J	0.01	0.47 J	0.14	14.4
	03-JUN-2004	6.7 U	8.2 U	54 U	6500 J	1.3	0.28	1.3	0.075	0.017	0.43	0.63	14
	30-JUL-2008	8.4	4.6 J	92 U	3200 J	0.66	0.28	0.74	0.060	0.027	0.39	0.19	11
S.STATION8	07-MAY-1996	12	NA	NA	1800 J	0.22	2.2	1.53	0.21	0.01	1.3	0.49	11.1
	02-JUN-2000	10 U	10 U	240	10000	0.3 UJ	0.49	1.35 J	0.06 J	0.01	0.41 J	0.12	13.7
	03-JUN-2004	6.7 U	8.2 U	54 U	1700 J	1.6	0.51	1.2	0.076	0.016	0.48	0.33	14
	30-JUL-2008	2.2 J	1.3 J	96 U	3800 J	0.6	0.24	0.95	0.070	0.016	0.35	0.18	10
S.STATION9	07-MAY-1996	21 J	NA	NA	2700 J	0.22	3.24	1.64	NA	0.01	1.9	0.37	14
	02-JUN-2000	10 J	10 J	230	11000	0.24 J	0.71	1.34 J	0.06 J	0.02	0.54 J	0.2	13.9
	03-JUN-2004	6.7 U	8.2 U	54 U	4200 J	0.7	0.20	1.0	0.072	0.02	0.59	0.48	14
	30-JUL-2008	3 J	1.9 J	90 U	3600 J	1.2	0.21	0.95	0.071	0.022	0.4	0.14	12
Mean[c,d]													
All Stations	1996	14	15	240	2125	2.0	3.0	1.6	0.170	0.034	0.911	0.637	14.300
	2000	8.1	13	71	7900	0.73	0.80	1.2	0.054	0.022	0.522	0.227	15.141
	2004	3.4	4.1	27	3856	1.72	0.622	1.15	0.067	0.038	0.645	0.587	13.919
	2008	2.8	2.2	46	2600	1.56	0.313	0.80	0.057	0.024	0.402	0.231	10.841

[a]Background screening value: 95th percentile, maximum value, or minimum detection limit value of samples from reference locations (U.S. Navy 1993)
[b]Location LB17 from the remedial investigation (U.S. Navy 1993) was immediately offshore of Area 8 and is considered subtidal, whereas Area 8 sediment locations (i.e., 1 through 9) are intertidal. Results of sediment sampling at the remedial investigation location and the 1996 monitoring locations are likely not directly comparable.
[c]One-half detection limit was used to calculate the mean for all nondetects.
[d]Mean of sampling locations (1–9) for each year.

Notes:
Data presented in this table were obtained from the Naval Installation Restoration Information Solution (NIRIS) database, where available. If not available in NIRIS, data were from the second 5-year review report (U.S. Navy 2005a).
Results are reported in wet-weight concentrations.
The June 2000 metals data obtained from NIRIS were reported on a dry-weight basis. Since percent solids data were not available, the results could not be converted to wet-weight concentrations. Therefore, wet-weight metals concentrations are included from the second 5-year review report (U.S. Navy 2005a).
The June 2004 and the July 2008 metals data were obtained from NIRIS in dry-weight concentrations. Since percent solids data were available for these two sampling events, the results were converted to wet-weight concentrations.

Table 6-13 (Continued)
Chemical Concentrations in OU 2 Area 8 Clam Tissue (1996 Through 2008)

Chemicals selected were metals that were elevated above background screening values at any location in Liberty Bay (U.S. Navy 1993). Organic chemicals were not detected in clam tissues from location LB17 during the remedial investigation.
Shaded columns indicate the most current sampling period results.
J - The result is an estimated concentration that is less than the MRL, but greater than or equal to the MDL.
µg/kg - microgram per kilogram
mg/kg - milligram per kilogram
MDL - method detection limit
MRL - method reporting limit
NA - not available or not analyzed
U - The compound was analyzed for, but was not detected ("nondetect") at or above the MRL/MDL.

7.0 TECHNICAL ASSESSMENT

7.1 FUNCTIONALITY OF REMEDY

This section answers the question, "Is the remedy functioning as intended by the decision documents?" Each component of the remedy for each OU is discussed in the sections that follow, generally in the order that the components were described in Section 4.

7.1.1 Functionality of Remedy for OU 1

Overall, the remedy for OU 1 has been implemented as intended by the ROD. However, the phytoremediation component of the remedy is not as effective as intended by the ROD. Per the language of the ROD (U.S. Navy, USEPA, and Ecology 1998, Section 11.1.1, first paragraph), the objective of the phytoremediation action is to reduce "the main sources of the TCE-family contamination in the landfill in order to improve conditions over the long term and to reduce the potential for these chemicals to cause unacceptable risks in the future." Thus the intent of this remedy "is to speed up the removal of TCE-family compounds at the source areas compared to that being accomplished by natural attenuation processes" (U.S. Navy, USEPA, and Ecology 1998, Section 11.1.1, second paragraph). The expectation in the ROD is that phytoremediation and natural attenuation are expected to work in concert to remove and degrade TCE-family compounds.

The ROD established that risks to human health and the environment at the site were acceptable at the time of the ROD, and focused the remedy on preventing future increases in risk:

> Test results have shown downgradient concentrations that (1) do not indicate current unacceptable risk to human health via the seafood ingestion pathway at locations where seafood resources now exist, (2) do not flow toward off-base drinking water resources, and (3) do not pose sufficient ecological risk to require active remediation of downgradient resources at this time. The site characterization studies indicate that this favorable situation will most likely continue in the future.

The conditions and COC concentrations found today in the landfill, marsh, and downstream receptors are similar to or better than those at the time of the ROD, when those conditions were found to be sufficiently protective of human health and the environment as long as exposures were controlled. Although Ecology and the Suquamish Tribe note in their interview responses the ongoing exceedances of RGs and migration of contaminants, these conditions do not call into question the protectiveness of the remedy as established in the ROD.

All components of the OU 1 remedy have been implemented. Implementation of phytoremediation, PCB-contaminated sediment removal, and the tide gate upgrade were complete prior to the first 5-year review. Institutional controls were also implemented prior to the first 5-year review, and LTM, maintenance, and inspection programs are in place. The landfill cover was upgraded during the second 5-year review period, and the Navy prepared and implemented a contingent remedial action plan in March 2003.

Functionality of Phytoremediation

The phytoremediation component of the remedy has not been as effective as intended by the ROD. The effectiveness of phytoremediation was assessed against the performance criteria established in the ROD and the original phytoremediation work plan (see additional discussion in Section 4.1.3 of this 5-year review).

Tree Health. The trees are healthy given the poor growing conditions at the site, which were acknowledged at the time of remedy implementation. The trees are not diseased and the plantation mortality is well below industry norms. The tree canopy is closed at each plantation, indicating that the water uptake capabilities of the two plantations have been maximized (all of the available solar insolation is being utilized by the plantations). The presence of larger trees would not substantially increase the groundwater uptake capabilities of the plantations. The original silviculture expert who helped design the phytoremediation system anticipated that the trees' capacity for water uptake could exceed the production capacity of the shallow aquifer, and therefore, the irrigation system was provided to supplement the water needs of the trees. By design, the trees are provided the minimum tap-water volume required to prevent water stress, to encourage the trees to seek out and take up contaminated groundwater. The health of the trees is not measurably different between the north and south plantations.

Groundwater Flow. Long-term monitoring of the groundwater elevation beneath both the north and south plantations has not revealed any discernible effect from the trees on groundwater elevation, flow direction, or gradient, as anticipated by the ROD. Detailed analyses of tidal effects on groundwater beneath the plantations and on transpiration imply both that the trees have difficulty in the summer drawing as much water from the low-productivity shallow aquifer as they could use (U.S. Navy 2006b) and that this performance criterion may not be sensitive enough to demonstrate effects by the trees (U.S. Navy 2003d).

Although groundwater uptake by the trees has not met the performance criteria established by the ROD, transpiration and groundwater elevation studies have shown other ancillary benefits to phytoremediation at the site. The closed tree canopy intercepts and allows the evaporation of a significant percentage of the precipitation falling on the plantations before this precipitation can infiltrate the landfill. The trees also intercept and use soil moisture from the vadose zone before

this soil moisture can migrate to the shallow aquifer. This interception of water inputs to the landfill should reduce the leaching of contaminants from the landfill during the growing season.

Contaminant Concentrations. Biodegradation has been a primary cause for the decreased contaminant concentrations beneath OU 1. According to the USGS (Dinicola 2006), "the evidence indicating biodegradation was a primary cause for the decreased concentrations includes decreasing ratios of more highly chlorinated compounds to less chlorinated compounds over time, and widespread detection of non-chlorinated biodegradation end-products ethene and ethane." The report goes on to say the following: "To reliably attribute the measured contaminant concentration trends to phytoremediation activities is difficult because of the substantial inter-annual variation in chloroethene concentrations measured at site MW1-16, the only nearby site with pre-1999 data. The post-1999 variation at the site MW1-16 in part may be due to more frequent than annual sampling and to different sampling techniques used by the Navy and the USGS." It is probable that phytoremediation is having some positive effect on contaminant reduction and, at the least, that phytoremediation does not appear to be impeding the natural biodegradation processes operating beneath OU 1. Phytoremediation appears to be reducing the infiltration of precipitation into the landfill surface, which should result in reduced leaching of contaminants from unsaturated soil into groundwater. Contaminant concentration decreases have been more substantial at the north plantation than the south plantation (where original contaminant concentrations were much higher and where the presence of DNAPL has been inferred).

Functionality of Natural Attenuation

As stated in the OU 1 ROD, it was anticipated that "source reduction by the poplar trees will work in concert with natural attenuation processes and decrease the overall time frame for cleansing of the site" (U.S. Navy, USEPA, and Ecology 1998). Thus, phytoremediation was not expected to perform as a stand-alone remedy. Section 11.1.6, first paragraph, of the ROD also states that "if phytoremediation is determined to be ineffective and is discontinued, natural attenuation and intrinsic bioremediation will be evaluated to determine whether they satisfy the key objectives for which the phytoremediation action was intended to address."

The ongoing monitoring and evaluation of intrinsic biodegradation has shown the continued existence of conditions, as stated in the ROD, "favorable for controlling the migration of contaminants downgradient from the landfill" (U.S. Navy, USEPA, and Ecology 1998). Intrinsic biodegradation has been found to consistently and substantially reduce concentrations of VOCs as they migrate in groundwater from the landfill to the adjacent marsh. This mechanism is not sufficient to reduce VOC concentrations to below RGs in the marsh. The favorable intrinsic biodegradation conditions are functioning as intended by the ROD to maintain the protection of human health and the environment and slowly reduce COC concentrations over time. Ecology expressed concern in their interview response that biodegradation processes are not effective in

the intermediate aquifer. However, the COC concentrations in the intermediate aquifer wells and biodegradation indicator parameters in the intermediate aquifer have not changed substantially over the last 10 years. The evaluation procedure established in the ROD for the groundwater monitoring data focuses on an assessment of whether the results indicate "adverse trends that indicate risks to receptors downgradient of the landfill will become unacceptable in the future." The intermediate aquifer data are not indicative of increasing risk, and therefore the remedy is functioning as the ROD intended.

Functionality of Sediment Removal

The removal of PCB-contaminated sediment successfully reduced the amount of PCBs present in marsh sediments. The ROD did not anticipate or require complete removal of PCB-contaminated sediment throughout the marsh, and PCBs are still detected in marsh sediments. The ROD also specifically excluded source control measures for PCBs in the landfill itself (page 82 of the ROD). PCB concentrations found in 2002, 2004, and 2009 sediment samples are below the screening values. PCBs were also detected in water samples from landfill seep SP1-1, and the ongoing monitoring program is functioning to assess the potential for long-term recontamination of the marsh. In their interview response, Ecology stated that the sediment removal component of the remedy has not been effective in reducing PCB concentrations in water from Seep SP1-1 to below the RG. However, groundwater discharging from Seep SP1-1 originates from beneath the landfill, where PCB source control measures were explicitly excluded in the ROD. Groundwater from Seep SP1-1 does not originate from within the area of the sediment removal, and therefore the concentrations of PCBs in samples from SP1-1 are not an indicator of the functionality of the sediment removal.

Functionality of Tide Gate

The tide gate is functioning to regulate the marsh water level, and no erosion of the landfill is apparent. Maintenance of the tide gate is being performed and documented.

Functionality of Landfill Cover Upgrade

The upgraded landfill cover is functioning to reduce infiltration into the landfill by improving the integrity of the existing impervious surface and by better controlling stormwater runoff. It is possible that the discharge of parking lot stormwater near location MA-11 is causing increasing metals concentrations in sediment samples from that location.

Functionality of Institutional Controls

Institutional controls are being inspected annually and the findings documented. These controls are functioning to control human exposures to contaminated soil and groundwater at OU 1.

Functionality of Long-Term Monitoring

LTM is being conducted regularly for all required media and is functioning to ensure the ongoing effectiveness of the remedy. The results are regularly evaluated to assess the remedy, the need to implement contingent remedial actions, and the need for modifications to the monitoring program. Based on the data review in Section 6.4, reductions in the monitoring program are warranted in some areas of OU 1, while an increase in monitoring is warranted for the groundwater to surface water pathway from the south plantation.

The July 2006 concentrations of 1,4-dioxane in shallow aquifer wells MW1-2 and MW1-41 and intermediate aquifer wells MW1-25, MW1-28, and MW1-38 exceeded the current MTCA Method B groundwater cleanup level for this compound. Additional sampling is warranted to verify the functionality of the remedy with regard to this compound.

7.1.2 Functionality of Remedy for OU 2

Functionality of Remedy for Area 2

The remedy for Area 2 is functioning as intended by the OU 2 ROD. The institutional controls component of the selected remedy has been implemented and maintained and acts to prevent human exposures to COCs in soil and groundwater. The groundwater monitoring component of the remedy has also been implemented. Groundwater wells are sampled regularly and the results evaluated to assess the need for continued institutional controls. The results are also evaluated to assess the adequacy of monitoring, and the monitoring program is adjusted as necessary, with input from Ecology. A monitoring frequency reduction is recommended as a conclusion of this review.

Functionality of Remedy for Area 8

The remedy for OU 2 Area 8 has been implemented as intended by the ROD. However, monitoring data show that cadmium concentrations are slowly increasing in the sediment and that 1,4-dioxane is present in one well, which raises concern about the effectiveness of the remedy. The Navy intends to perform an additional investigation of the groundwater to surface water/sediment pathway and conduct further sediment sampling to determine the nature and extent of sediment contamination. The human health risk assessment will be completed following additional sediment and marine tissue sampling. The need for contingent groundwater control actions will be evaluated based on that completed human health risk assessment, as well as additional evaluation of ecological risks.

The institutional controls component of the selected remedy has been implemented and maintained and acts to prevent human exposures to COCs in soil and groundwater. The removal and off-site disposal of vadose-zone soil from COC hot spots was complete prior to the first

5-year review. Groundwater, sediment, and tissue monitoring has been ongoing since 1995, with the results evaluated regularly to assess the effectiveness of the remedy and the adequacy of the monitoring. The June 2007 concentration of 1,4-dioxane in well MW8-11 exceeded the current MTCA Method B groundwater cleanup level for this compound, and additional sampling is warranted to verify the functionality of the remedy with regard to this compound.

The ROD anticipated that after the soil removal component of the remedy "residual contamination may continue to be discharged into Liberty Bay for many years." The test in the ROD (pages 142 and 143) for whether groundwater control measures or further investigations must be implemented is whether the "discharges accumulate over the long-term" and if a post-ROD risk assessment "shows unacceptable risks or exceedances of state sediment cleanup screening levels." Ecology expressed concern, stated in their interview response, that "the excavation and off-site disposal of vadose-zone soil is not effective in preventing the migration of contaminants to Liberty Bay." However, the remedy was not intended to prevent such migration, as recognized in the ROD, unless the ongoing risk warranted groundwater control actions.

In preparation for this 5-year review, the Navy performed a human health risk assessment as required by the ROD and based on the 2008 sediment and clam tissue data. However, based on new information, such as the EPA Region 10 recommendations for using the Suquamish Tribe ingestion study in risk assessment, the Navy, Suquamish Tribe, EPA, and Ecology jointly decided not to use the risk assessment in this 5-year review. Instead, the parties agreed to collect additional data and perform a follow-on risk assessment.

7.1.3 Operation and Maintenance Costs

Annual operation, maintenance, and monitoring (OM&M) costs after the first 3 years were estimated in the RODs to total approximately $250,000 per year. Actual annual OM&M costs for fiscal years 2000 through 2004 ranged from $263,000 to $366,000 per year. The actual costs are near the costs expected in the ROD.

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 RODs and reviews any changes to risk assessment assumptions (exposure and toxicity) to evaluate the protectiveness of the remedy.

Concentrations of chemicals in groundwater remain above the RGs at the majority of locations in OU 1 and OU 2, resulting in the need for continued institutional controls to prevent exposure and ongoing monitoring. Although some of the 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.

For 1,1-DCE at OU 1 (ROD RG established as the practical quantitation limit [PQL]), decreases in toxicity indicate that while concentrations still occasionally exceeded the ROD RGs, these concentrations no longer represent a health risk. In addition, although 1,1-DCE still exceeds the MCL established as the RG for OU 2 Area 8 groundwater, the concentrations do not exceed the current health-based MTCA Method B value.

RGs were not established for clam tissue and sediment at OU 2 Area 8. Rather, the ROD specified that risk evaluations were to be conducted using LTM data to assess health risks and data trends. Human health and ecological risk assessments were first performed in accordance with this ROD requirement as part of the second 5-year review. The results of the updated ecological risk assessment conducted using the latest data (collected in 2008) are presented in Section 7.3. Completion of the updated human health risk assessment has been postponed until additional data have been collected, per discussions among the Navy, EPA, Ecology, and the Suquamish Tribe.

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 2001a) establishes that the question of interest in conducting 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 and the new standards 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 risk comparison is provided in Section 7.2.2 where the risk assessment assumptions are discussed.

During the first and second 5-year reviews for NBK Keyport, no substantive changes to ARARs were found that would call into question the protectiveness of the remedy. For this third 5-year review, all the ARARs identified in the RODs for OU 1 and OU 2 Area 8 were again reviewed for changes that could affect the assessment of whether the remedy is protective.

Some ARARs that were used in the determination of cleanup levels have been amended since publication of one or both of the two RODs. These regulations are the following:

- Washington State MTCA regulations
- Federal and state drinking water regulations (MCLs)
- Washington State marine surface water quality standards for protection of aquatic life

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.

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.

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OU 1 RGs for COCs were established for groundwater, surface water, sediment, and clam tissue. The basis for the cleanup levels was the protection of human health if groundwater was used for drinking, if surface water contained a food source, or if clams were harvested by a subsistence population (U.S. Navy, USEPA, and Ecology 1998). For sediment, no specific numeric RGs were established. Instead, the ROD indicated that bioassays would be conducted if sediment concentrations exceeded SQS. No numeric RGs were established for the landfill soil. Instead, the ROD indicated that institutional controls would be maintained to prevent contact with landfill soil and vapor. For groundwater, surface water, and clam tissue, the COCs with numeric RGs are nine chlorinated solvents and PCBs. In addition, the ROD identified a number of "chemicals of interest" (COIs) in sediment and clam tissue for inclusion in the LTM program for sediment and shellfish. However, no RGs were established for the COIs. Specific COIs in sediment were acenaphthene and phenol, based on the supplemental ecological risk assessment. COIs in clam tissue were arsenic, beryllium, chromium, lead, mercury, nickel, and zinc, based on the supplemental human health and ecological risk assessments using the 1995/1996 data. A chemical was selected as a COI if the maximum concentration exceeded one-third of the lowest risk-based screening level.

Groundwater. Table 7-1 compares current ARAR values for the groundwater pathway with those presented in the OU 1 ROD (U.S. Navy, USEPA, and Ecology 1998, Table 11-4). The ARARs are defined for groundwater as a source of drinking water and as a contributor to surface water. PCE's RG was based on the MCL, which has not changed. However, according to procedures specified in Ecology's methodology to assess the protectiveness of MCLs (WDOE 1993), the MCL for PCE would not meet WAC 173-340-720(3)(a) requirements as "sufficiently protective" if the evaluation were to be done today.

There would be no change to the other RGs based on drinking water standards if they were calculated today, except for the three chemicals where the ROD RG was the PQL: 1,1-DCE, vinyl chloride, and PCBs. Most laboratories can now achieve PQLs of 0.02 µg/L for 1,1-DCE and vinyl chloride (requires selected ion monitoring [SIM] analysis), as opposed to the PQL of 0.5 µg/L used as the RGs for these chemicals in the ROD. PQLs in recent monitoring rounds are primarily the ROD values and not the lower, currently achievable PQLs (see Table 6-1). For 1,1-DCE, a revised risk value would be higher today (see Section 7.2.2), and, therefore, it is not necessary to achieve a low PQL. For vinyl chloride, because the majority of the groundwater data still significantly exceeds even the ROD value (Table 6-1), concerns about achieving lower PQLs are premature. See further discussion in Section 7.2.2 regarding potential RG revisions for vinyl chloride and 1,1-DCE because of changes in toxicity. For PCBs, the change in PQL is not significant. It may be possible for some laboratories to achieve a slightly lower PQL for PCBs of 0.02 µg/L, rather than the ROD RG of 0.04 µg/L. PQLs used in recent monitoring rounds for PCBs are primarily 0.04 µg/L.

Changes to groundwater RGs based on protection of surface water are discussed in the surface water section below.

The last 5-year review in 2005 recommended that a new chemical, 1,4-dioxane, be added to the groundwater analyte list, because of its potential to be present in chlorinated solvent plumes. Therefore, post-2005 monitoring has included 1,4-dioxane. Because it is a new chemical, no cleanup level was established in the ROD. However, there is a current MTCA Method B value, and it is included on Table 7-1.

Surface Water. Table 7-1 also compares current ARAR values for surface water with those provided in the OU 1 ROD (U.S. Navy, USEPA, and Ecology 1998, Table 11-5). For the following two chemical constituents listed in the OU 1 ROD, the new ARAR values are lower or more stringent:

- **PCE:** 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 4.2 µg/L, and the current value is

0.387 µg/L. Therefore, PCE's RG based on the MTCA Method B value would decrease from 4.2 to 0.387 µg/L if established today.

- **TCE:** 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. Therefore, TCE's RG based on the MTCA Method B value would decrease from 56 to 6.7 µg/L if established today.

Clam Tissue. Clam tissue RGs were established for the nine VOCs identified as COCs and for PCBs. Because VOCs were never detected in clam tissue, they have been dropped from the analyte list and the original RGs are no longer included for review. The RG for PCBs was a site-specific risk-based level protective of subsistence-level ingestion of clams. The applicability of the risk assessment assumptions used to calculate the value of 0.015 mg/kg are discussed further in Section 7.2.2.

RGs were not established for the seven metals identified in the ROD as COIs for clam tissue. The ROD indicated that "*if clam tissue results exceed the remediation goals or if adverse spatial or temporal trends indicate that the remediation goals will be exceeded in the future, the Navy will evaluate what further action should be taken*." Spatial and temporal trends for the COIs are addressed in Section 6.

Operable Unit 2 Area 2

There are two sites within OU 2 subject to the 5-year review process: Area 2 and Area 8. Area 2 COCs are vinyl chloride and TCE in groundwater, based on humans drinking the water. Vinyl chloride was also identified as a COC in soil as a potential human health concern if the site were to be developed for residential use. However, only one out of 21 samples had a detected vinyl chloride value, and no other chemical in soil was identified as a concern in the risk assessments or the ROD (i.e., all soil risks were less than or equal to 1×10^{-5} except vinyl chloride). The ROD RG for TCE was established as the MCL (5 µ/L), and there has been no change to the chemical's MCL. For vinyl chloride, the ROD RG was the PQL. The MCL at the time for vinyl chloride was 2 µg/L. However, using Ecology's methodology to assess the protectiveness of MCLs, the MCL for vinyl chloride did not meet WAC 173-340-720(3)(a) requirements as "sufficiently protective." Therefore, the MTCA Method B value would apply (0.023 µg/L is listed in the ROD). Because the MTCA Method B value was below the PQL at the time, the RG was established as the PQL. As noted above for groundwater in OU 1, the PQL for vinyl chloride would be lower, closer to the Method B value, using today's laboratory techniques. As shown on Table 6-7, the PQL for vinyl chloride consistently used in the LTM program is 1 µg/L. The current lowest possible PQL (0.02 µg/L using EPA Method 8260C SIM analysis) is not being met.

Operable Unit 2 Area 8

The ROD for Area 8 identified three COCs in soil, based on residential land use: arsenic, cadmium (if ingested in home-grown produce), and chromium. However, arsenic was considered at background. In Area 8 groundwater, the risk assessment identified cadmium, chromium, and TCE as COCs with hazard quotients (HQs) greater than 1 and five additional COCs with cancer risks exceeding 1×10^{-5}, if the shallow aquifer were used for drinking water (carbon tetrachloride, chloroform, 1,2-DCA, 1,1-DCE, and 1,1,2-TCA).

Soil. RGs for cadmium and chromium were not specifically established. The ROD identified "soil removal action levels" of 80 mg/kg for cadmium, 400 mg/kg for chromium VI, and 80,000 mg/kg for chromium III (all MTCA Method B values for soil ingestion). No action level was established for total chromium. An ESD to the ROD in 1996 established 400 mg/kg as the removal action level for total chromium, and chromium speciation in soil was not performed. Current MTCA Method B soil ingestion values have not changed for cadmium. However, chromium VI's Method B value today is 240 mg/kg, approximately half the soil action level in the ROD. Subsequent to the hot spot soil removal action at Area 8, the maximum remaining chromium concentration in soil was 207 mg/kg (U.S. Navy 1999d). Therefore, changes to the soil action level do not affect the protectiveness of the remedy.

Groundwater. The LTM program at Area 8 has been tracking cadmium, chromium, TCE, PCE, 1,1-DCE, cis-1,2-DCE, and 1,1,1-TCA in groundwater based on detections above ARARs. Other chemicals noted in the ROD as having been identified in the risk assessment as COCs or potential COCs, have either not been detected, or detections have been very low. Therefore, the seven chemicals included in the current LTM program have been established as the COCs for the site.

The ROD identified two RGs for each COC, one for protection of the water for drinking and one based on protection of surface water. There are changes to three surface water ARARs, 1,1-DCE, PCE, and TCE (Table7-2). If established today, 1,1-DCE's surface water RG would be higher (i.e., less conservative) and the surface water RGs for PCE and TCE would both be lower. The surface water RG for PCE would change from 8.9 to 3.3 µg/L if established today, while the surface water RG for TCE would change from 81 to 30 µg/L.

For drinking water, Table 7-2 compares current ARARs values for the LTM COCs to those presented in the OU 2 ROD (U.S. Navy, USEPA, and Ecology 1994, Table 10-12). Two drinking water values would be lower if calculated today – chromium VI and PCE. Chromium VI's toxicity value has changed (discussed in Section 7.2.2). For PCE, in accordance with WAC 173-340-720(3)(a) and Ecology Implementation Memo No. 1 (WDOE 1993), the MCL for PCE is not sufficiently protective when compared to the new MTCA B drinking water value. Therefore, the MCL would no longer be acceptable if a cleanup level were to be established

today, i.e., the cancer risk level at the MCL would exceed 1 x 10^{-5}. Detected concentrations of PCE in Area 8 wells still primarily exceed the MCL. At the point where LTM would be discontinued, RGs should be reviewed to ensure their protectiveness.

Two drinking water values would be higher if established today: total chromium and chromium III. For total chromium, the ROD RG was based on a State MCL of 50 µg/L. The MCL today is 100 µg/L. Note that the recent detections of total chromium in Area 8 monitoring wells MW8-8 and MW8-12 are above 50 µg/L but are at or below 100 µg/L. Consequently, total chromium concentrations in these wells would now be considered safe to drink, if the percent of the total chromium present as chromium VI was low. If chromium VI is present in significant amounts (chromium VI is no longer being analyzed at Area 8), then chromium VI's RG is still exceeded. The protectiveness of the remedy for all forms of chromium is unaffected.

Chromium III's RG based on the MTCA Method B value would increase from 16,000 to 24,000 µg/L if established today. Chromium III is not included in the analyte list for the long-term groundwater monitoring, and increases in RGs indicate lower toxicity. Therefore, potential changes to chromium III RGs do not affect the protectiveness of the remedy.

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. For human health, there are potentially two areas where changes could have occurred since the signing of the RODs: toxicity values for select chemicals and assumptions regarding human activity (i.e., exposure assumptions). How these changes to toxicity and exposure parameters might affect the protectiveness of the remedy is discussed below.

Toxicity Criteria

For those ARAR values that are based on a human health risk-based number (e.g., MTCA Method B groundwater cleanup level), changes to toxicity criteria may raise or lower the current regulatory level in comparison to values established as RGs in the ROD. If Method B values were to be calculated now, revisions to the toxicity criteria for eight chemicals would result in different MTCA Method B values than those presented in the RODs. Toxicity values have changed for chromium III, chromium VI, 1,1-DCA, 1,1-DCE, PCE, 1,1,1-TCA, TCE, and vinyl chloride since completion of the RODs. For three of the seven (chromium VI, PCE, and TCE), RGs calculated today would be lower (i.e., more stringent). For these three chemicals, the health risks of the ROD RG are compared with today's RG. This comparison is done to assess whether the currently calculated risks associated with the ROD RG are still within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}, or below a hazard index (HI) of 1 for noncancer effects (see Table 7-3 for OU 1 chemicals and Table 7-4 for OU 2 chemicals). For the five chemicals

with higher RGs if calculated today (i.e., less stringent), an explicit comparison of risk levels is unnecessary, because the ROD RGs were based on an assumption that the chemicals are more toxic (lower RGs) than would be assumed today. However, details of RG changes for these chemicals are also included on Tables 7-3 and 7-4. 1,1-DCA is not included in the chemical-specific discussions below because it is not known why the MTCA Method B value is higher today (see Table 7-3).

Chromium VI. Chromium VI is a COC in OU 2 Area 8. The drinking water RG in the ROD is 80 µg/L, based on the drinking water MTCA Method B value at the time the ROD was signed in 1994. In 1998, the reference dose (RfD) for chromium VI was lowered to 0.003 mg/kg-day in EPA's Integrated Risk Information System (IRIS) (USEPA 2009a). Therefore, if the MTCA drinking water value was calculated today, the value would be 48 µg/L. Using the new RfD, the noncancer hazard of the RG of 80 µg/L is 2, which is above the ROD target health goal of 1. Only total chromium is being monitored at Area 8. If 100 percent of the total chromium in groundwater is in the chromium VI form, then chromium concentrations in monitoring wells MW8-8, MW8-11, and MW8-12 are still exceeding both the ROD RG and today's lower level. Because the remedy is preventing use of the water for drinking, the remedy remains protective and not affected by the change in chromium VI toxicity. When monitoring indicates that concentrations are below the ROD RG and a proposal is put forward to remove the institutional controls, the cleanup levels would need to be recalculated based on ARARs and toxicity criteria at that time to ensure that conditions at the site would be protective in the absence of institutional controls.

The chromium VI surface water RG for OU 2 is based on protection of marine life. The marine life RG of 50 µg/L has not changed and is also protective of human health, even when the adjusted toxicity of chromium VI is taken into consideration. Seep concentrations in recent monitoring rounds are well below a concentration of 50 µg/L.

1,1-Dichloroethene. 1,1-DCE is a COC in groundwater at both OU 1 and OU 2. The RGs for drinking water and surface water were different for each OU. However, in all cases, today's RGs would be higher than the respective ROD values, because EPA has withdrawn the cancer slope factor for this chemical and no longer considers it a potential carcinogen. Therefore, if a MTCA Method B drinking water or surface water value were calculated now, it would be based on noncancer toxicity and would be higher than the RG listed in either ROD. Therefore, there is no impact on the protectiveness of the remedy. However, it should be noted that at some locations current concentrations of 1,1-DCE in groundwater do not pose a health risk, although there may still be exceedances of the ROD RG.

Tetrachloroethene. PCE is a COC in groundwater at both OU 1 and OU 2. The drinking water RGs for the chemical at both OUs was the MCL of 5 µg/L, which has not changed. However, because the toxicity criteria has increased (i.e., the chemical is considered more toxic than when

the RODs were signed), following Ecology policy regarding the use of MCLs (WDOE 1993), the MCL for PCE is not sufficiently protective when compared to the new MTCA Method B drinking water value. Therefore, the MCL would no longer be acceptable if a cleanup level were to be established today, i.e., the cancer risk level at the MCL would exceed 1×10^{-5}. The remedies that prevent groundwater use as a drinking water source remain protective. When monitoring indicates that concentrations are below the ROD RG and a proposal is put forward to remove the institutional controls, the cleanup levels would need to be recalculated based on ARARs and toxicity criteria at that time to ensure that conditions at the site would be protective in the absence of institutional controls.

The surface water RGs were different at each OU (4.2 µg/L at OU 1 and 8.9 µg/L at OU 2). Based on the latest toxicity criteria for PCE, new risk-based values would be more than an order of magnitude lower than these two RGs. EPA's current oral slope factor for PCE is 0.54 $(\text{mg/kg-day})^{-1}$ developed by California's Office of Environmental Health Hazard Assessment (OEHHA) (OEHHA 2002). Using the California OEHHA oral slope factor, the new MTCA Method B value is 0.39 µg/L. Using the current slope factor, the cancer risk of the former MTCA Method B surface water value of 4.2 µg/L at OU 1 is 1×10^{-5} and is therefore protective. At OU 2, the RG of 8.9 µg/L represents a 2×10^{-5} cancer risk calculated using the latest slope factor.

PCE has never been detected in surface water at OU 1. Therefore, potential RG changes are not relevant. At OU 2 Area 8, recent samples collected at Seep A have had detections close to the new MTCA Method B surface water value of 0.39 µg/L, while concentrations at Seep B have generally been below this level. Therefore, the remedy remains protective.

1,1,1-Trichloroethane. This chemical is a COC at both OU 1 and OU 2. The RGs for this chemical in both RODs were the same, the MCL of 200 µg/L for drinking water and a surface water RG of 42,000 µg/L. The MCL has not changed and remains as protective under MTCA. The EPA's National Center for Environmental Assessment (NCEA) has revised their provisional RfD for 1,1,1-TCA from 0.02 mg/kg-day used in the surface water RG calculations to 0.089 mg/kg-day, based on updated toxicity information. If the current oral RfD is used to calculate the MTCA Method B surface water value, the value would change from 42,000 µg/L to 416,666 µg/L. Therefore, the remedy designed to achieve the ROD surface water RG value is still protective. No concentration of 1,1,1-TCA has exceeded any ROD RG value in the last 10 years of monitoring at either OU 1 or OU 2.

Trichloroethene. TCE is a COC in groundwater at both OU 1 and OU 2. The drinking water RG for both OUs is the MCL of 5 µg/L, which has not changed. Surface water RGs were 55.6 µg/L at OU 1 and 81 µg/L at OU 2, based on MTCA and federal ambient water quality criteria (AWQC) values, respectively, and both of these values have changed. EPA does not have TCE cancer toxicity criteria in its IRIS database (USEPA 2010a). However, interim cancer

criteria are being used in EPA Region 10 and by Ecology (USEPA 2008 and WDOE 2004). Different interim toxicity criteria are being used at the national level than are being used in Region 10 (USEPA 2010b). Nationally, EPA uses the California EPA cancer criteria from California's OEHHA data base (OEHHA 2009) to assess TCE carcinogenicity. Late in 2009, EPA published an "external review draft" toxicological evaluation document for TCE that proposed toxicity criteria for the IRIS database that are different from both the EPA Region 10/Ecology interim values and the California EPA values (USEPA 2009b). After receiving comments on the external draft, EPA may make changes to its recommendations prior to placing final toxicity criteria in IRIS, expected to occur in late in 2011, or possibly 2012. Potential changes to the surface water RGs due to changes in TCE toxicity are discussed for each OU below.

For OU 1, the surface water RG of 55.6 µg/L was the MTCA Method B value for surface water at the time and was based on an oral cancer slope factor of 0.011 $(mg/kg\text{-}d)^{-1}$. That slope factor has been withdrawn from use by EPA. The MTCA Method B surface water value of 6.7 µg/L currently in Ecology's CLARC database is calculated using EPA Region 10 and Ecology's current interim oral cancer slope factor of 0.089 $(mg/kg\text{-}d)^{-1}$ (https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx). Using the same toxicity and exposure inputs as are used to estimate the latest MTCA Method B surface water cleanup level, the RG of 55.6 µg/L represents a health risk of 8×10^{-6}. This health risk is within EPA's target risk range of 10^{-4} to 10^{-6} and below the ROD goal of 1×10^{-5}. At OU 1, concentrations of TCE in surface water at MA-12 still exceed the RG of 55.6 µg/L, and no other location exceeds the latest MTCA Method B value of 6.7 µg/L (see Table 6-3).

For OU 2, the ROD established a surface water RG of 81 µg/L, which was the federal AWQC, human health organisms only, at the time the ROD was signed. The same AWQC value today is 30 µg/L, because of changes in AWQC calculation methodology, not toxicity assumptions (an increase in the default fish ingestion rate to 17.5 g/day from 6.5 g/day) (http://water.epa.gov/scitech/swguidance/waterquality/standards/current/index.cfm). The cancer toxicity criteria used to calculate both the RG value of 81 µg/L and the latest value of 30 µg/L is 0.0126 $(mg/kg\text{-}d)^{-1}$ (USEPA 2002). Using EPA Region 10 and Ecology's interim oral cancer slope factor of 0.089 $(mg/kg\text{-}d)^{-1}$ and the MTCA Method B surface water exposure information, the RG of 81 µg/L represents a health risk of 1×10^{-5}. This health risk is within EPA's target risk range of 10^{-4} to 10^{-6}. At OU 2, concentrations of TCE at Seeps A and B have been declining over time, and only one sample at Seep A in the last 5 years has exceeded the latest MTCA Method B value of 6.7 µg/L (see Table 6-9).

The remedy remains protective with respect to TCE because of the presence of institutional controls that continue to prevent exposure to TCE concentrations exceeding the RGs, in spite of the fact that the RGs would be lower if calculated today.

Vinyl Chloride. This chemical is a COC in groundwater and surface water at OU 1 and also a COC in groundwater at OU 2 Area 2. Because the MTCA Method B value protective of drinking water was lower than the PQL, the RGs protective of drinking water were established at a PQL of 0.5 µg/L for OU 1 and a PQL of 1 µg/L for Area 2. The oral slope factor for vinyl chloride, as reported in IRIS (USEPA 2009a), has changed from 1.9 to 1.5 $(mg/kg\text{-}day)^{-1}$. If the current oral slope factor is used to calculate the MTCA Method B value protective of drinking water, the value would be 0.029 µg/L, and that value is achievable by today's laboratories. At OU 1, there are still significant concentrations of vinyl chloride detected. However, the remedy is protective as long as restrictions remain on the use of groundwater for drinking. When monitoring indicates that concentrations are below the ROD RG and a proposal is put forward to remove the institutional controls, the cleanup levels would need to be recalculated based on ARARs and toxicity criteria at that time to ensure that conditions and the subject site would be protective in the absence of institutional controls. The situation at OU 2 Area 2 is similar to OU 1. There are detections above the ROD RG. However, the institutional controls are in place to prevent groundwater use for drinking. If institutional controls are removed, the RG will need to be reevaluated.

For the surface water RG at OU 1, a slightly higher cleanup level would be calculated today, changing it from 2.92 to 3.7 µg/L. This change would not influence the protectiveness of the remedy. MA-12 is the only surface water location in OU 1 where concentrations are still significantly exceeding the RG in recent monitoring, and the new MTCA surface water RG would also be significantly exceeded. All other surface water concentrations meet the ROD RG in recent monitoring and today's value would be higher.

Exposure Parameters

The original risk assessment for both OUs did not find health risks in excess of target health goals from consumption of shellfish in Liberty Bay or Dogfish Bay adjacent to NBK Keyport. In the OU 1 ROD (Dogfish Bay) it was noted that concentrations of COCs, particularly PCBs, could be increasing. However, the LTM program has not found increasing trends, and PCBs were only detected at one sampling location (TF-21) in 1996 and 2000 (see Table 6-6). If a risk assessment were to be conducted today at OU 1, it is likely that different fish/shellfish ingestion rates would be used than those in the original assessment. However, the COCs and associated RGs established for shellfish (COCs included several VOCs and PCBs, and COIs included several metals and SVOCs) are not a concern in Dogfish Bay because (1) VOCs were never detected and monitoring for these compounds has been discontinued, (2) PCBs were only detected twice in the tide flats (1996 and 2000) and have never been detected off Navy property, and (3) spatial and trend analysis of the COIs do not show that the landfill at OU 1 is the source of COIs to Dogfish Bay.[1] Therefore, new fish/shellfish ingestion rates or other changes in risk

[1]The ROD stated that COIs would be further addressed *"if clam tissue results exceed the remediation goals or if*

assessment information are not relevant. The ROD also identified a "COI" category of compounds, seven metals, but did not specify RGs.

The OU 2 ROD did not provide tissue-based RGs for shellfish. Shellfish near Area 8 were identified in the ROD as requiring further evaluation to assess whether active measures were needed to address contamination in groundwater impacting the bay. Human health and ecological risk assessments were first performed in accordance with this ROD requirement as part of the second 5-year review. The results of the updated ecological risk assessment conducted using the latest data (collected in 2008) are presented in Section 7.3. Completion of the updated human health and ecological risk assessment has been postponed until additional data have been collected, per discussions among the Navy, EPA, Ecology, and the Suquamish Tribe.

Although not a Navy-controlled institutional control, shellfish harvesting is currently restricted in both bays by the Washington State Department of Health. Restrictions were originally due to biological contamination from septic and sewage discharges, not from any chemical impacts from activities at Keyport. Recent communication with the Department of Health indicated that closure is being maintained primarily because of two large marinas in the immediate area (marina closure zone) (Cleland 2009). Water samples from the two bays have not been collected and analyzed by the Department of Health since the early 1990s.

7.3 RISK EVALUATIONS OF SEDIMENT AND CLAM TISSUE AT OU 2 AREA 8

As noted in Section 4.2.2, the ROD specified that post-ROD sediment and clam tissue samples from Liberty Bay were to be evaluated using risk assessment procedures to assess whether health risks were present. The results of the evaluation were to be used to assess whether further remedial actions were needed for groundwater entering Liberty Bay. Human health and ecological risk assessments were first performed in accordance with this ROD requirement as part of the second 5-year review. Completion of the updated human health risk assessment has been postponed until additional data have been collected, per discussions among the Navy, EPA, Ecology, and the Suquamish Tribe. Section 7.3.1 summarizes the status of the human health risk assessment for Area 8. The results of the updated ecological risk assessment conducted using the latest data (collected in 2008) are presented in Section 7.3.2.

7.3.1 Human Health Risk Assessment for Sediment and Clam Tissue at OU 2 Area 8

The ROD for OU 2 Area 8 specified that sediment and tissue (clams) from the shoreline of Liberty Bay near Area 8 were to be sampled and evaluated as part of future 5-year reviews (U.S. Navy, USEPA, and Ecology 1994). The ROD indicated that future sampling and analysis was

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adverse spatial or temporal trends indicate that the remediation goals will be exceeded in the future."

needed because of ongoing discharges of groundwater contaminated with metals associated with former metal plating activities at Area 8—primarily cadmium and chromium. The results of the evaluation were to be used to assess whether further remedial actions were needed for groundwater entering Liberty Bay.

Human health issues related to sediment and seafood exposures at Area 8 will be further evaluated for the next 5-year review with the initial task consisting of developing a sampling plan and risk assessment work plan. As part of the development of both plans, agreements will need to be reached regarding chemicals of potential concern, defining the potentially impacted exposure area, identifying relevant species of concern, and identifying the exposed populations and their exposure parameters. The ROD required that the same exposure parameters used in the ROD be used in subsequent risk assessments. However, since the ROD, the Suquamish Tribe has conducted a seafood ingestion study of the Tribe's population, and the exposure parameters for seafood ingestion are significantly different than those in the ROD. In addition, EPA Region 10 has published new guidance for conducting tribal seafood risk assessments. How this new information is used in future risk assessment work and how it might impact sampling and risk assessment calculations and conclusions will be issues that will be decided in consultation with EPA, Ecology, and the Suquamish Tribe during the development of the work plans.

7.3.2 Ecological Risk Assessment for Clam Tissue at OU 2 Area 8

To comply with the ROD requirements that ecological health risks be evaluated for the clam and sediment data at Area 8, a Tier 2 ecological risk evaluation (ERE) was performed for the intertidal zone at Area 8 (U.S. Navy 2009b). Shallow groundwater on site discharges to Liberty Bay via seeps in the intertidal zone, and this groundwater has been found to contain cadmium associated with past plating shop activities. The conclusion of the screening-level ecological risk assessment (SLERA) conducted in 2005, as stated in the second 5-year review, was that there is a potential for cadmium in sediments to pose a risk to aquatic biota and that further investigation may be warranted. Because cadmium concentrations in Seep A and in sediment exceeded screening levels, cadmium may be adversely affecting aquatic biota. The 2005 SLERA used conservative, default exposure and toxicity assumptions to identify a potentially unacceptable risk posed by cadmium. To address this concern, a Tier 2 ERE was performed (U.S. Navy 2009b) that relies on site-specific information to more realistically assess potential current and future risk to biological resources from cadmium exposure at Area 8. A summary of the ERE is presented here.

Marine sediment and clam tissue samples have been collected during four monitoring events (1996, 2000, 2004, and 2008) from nine locations (Stations 1 through 9) distributed along three beach-normal transects (Transects 1, 2, and 3) in the Area 8 intertidal zone. Stations 1, 4, and 7 are located along Transect 1; Stations 2, 5, and 8 are located along Transect 2; and Stations 3, 6, and 9 are located along Transect 3. Results of cadmium analyses for all these samples are used

in this ERE to evaluate whether unacceptable adverse effects to ecological receptors are occurring in the Area 8 intertidal zone.

The 2008 sampling event included two acute and one chronic bioassay toxicity test conducted on sediment collected from Station 3, which has been shown to contain some of the highest detected concentrations of cadmium detected in marine sediment samples collected since 1996. In addition to the bioassay testing, concentrations of cadmium in sediment and clam tissue samples were compared to protective criteria, and an ecological HQ value was generated for each detection. To assess potential impacts of cadmium detected in clam tissue to predator species consuming clams, concentrations of cadmium in clam tissue were compared to tissue levels protective of avian and mammalian wildlife. Acid-volatile sulfide and simultaneously extracted metals (AVS/SEM) analyses were also performed on sediment samples to evaluate whether cadmium and other metals were present at concentrations that were bioavailable to marine aquatic biota.

Results of the bioassay tests indicate that the sediments at the tested location are not causing toxicity to aquatic organisms. Comparison of detected concentrations of cadmium in sediment and clam tissue indicates that at certain stations, protective criteria were exceeded. However, the results of the bioassay are considered to provide more accurate information about true site-specific toxicity of the sediments than are the comparisons to criteria. Nonetheless, the results of the criteria comparison provide good information about which stations require continued monitoring. The results of the AVS/SEM testing in 2008 indicated that cadmium detected in sediments collected from Stations 6, 7, 8, and 9 are likely not bioavailable to aquatic biota.

Continued monitoring of cadmium in marine sediments and clam tissue is recommended at Transects 2 and 3 because of the potentially increasing cadmium concentration trends observed in these areas. No exceedance of the Washington State SQS or cleanup screening level for cadmium has been noted along Transect 1. Although minor exceedances of the National Oceanic and Atmospheric Administration effects range—low have historically been observed at Stations 4 and 7, the historical cadmium concentrations measured at these stations have remained well below the cadmium concentration measured in sediment used for the 2008 bioassay tests, during which no significant toxicity was observed. Further, the trends in cadmium sediment and tissue data in Transect 1 are within the normal range of variability, suggesting that cadmium levels are at a relative steady state and significant environmental impacts at the levels currently observed are unlikely. As such, it is recommended that Transect 1 be removed from the monitoring program.

EPA, Ecology, and the Suquamish Tribe do not agree with the ecological risk evaluation performed based on the 2008 data, and performance of additional ecological risk evaluation is therefore a recommendation of this 5-year review.

7.4 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.

7.5 TECHNICAL ASSESSMENT SUMMARY

The remedies at OU 1 and OU 2 were implemented and have been operating for at least a decade (10 years of operation at OU 1 and 15 years of operation for OU 2). Components of the remedies for OU 1 and OU 2 are functioning as intended by the two RODs. However, some concerns have been identified as a result of this third 5-year review. Concentration trends are slightly downward for most COCs in most media at most monitoring locations, indicating modest progress towards meeting RAOs. Natural attenuation processes are functioning to reduce COC concentrations, while exposures are prevented by institutional controls. COC concentration trends are tracked and evaluated through regular monitoring. At OU 1, phytoremediation has not been as effective as originally anticipated when it was evaluated during remedy selection, and 1,4-dioxane is present in groundwater beneath OU 1 and OU 2 Area 8 at concentrations exceeding the current MTCA Method B cleanup level. There is uncertainty as to why cadmium concentrations in sediment at OU 2 Area 8 are trending slowly upward. Additional monitoring to assess COC trends in sediment and clam tissue and additional ecological and human health risk assessments are warranted.

7.6 ISSUES

Table 7-5 lists the issues identified as a result of this 5-year review that appear to have the potential to affect the protectiveness of the remedies at NBK Keyport.

Table 7-1
Groundwater and Surface Water ARARs for OU 1

Chemical	Drinking Water Pathway						Surface Water Protection Pathway				
	ROD RG (µg/L)	Basis of ROD RG	Current MTCA Method B (µg/L)	Current Federal and State MCL (µg/L)	Current PQL as Applicable (µg/L)	Change in RG if established today?	ROD RG Based on MTCA Method B Surface Water (µg/L)	Current NTR Organisms Only (µg/L)	Current MTCA Method B Surface Water Value (µg/L)	Current PQL as Applicable (µg/L)	Change in RG if established today?
1,1-DCA	800	MTCA B, drinking water	1600	None		Yes, higher	None	None	None	NA	NA
1,2-DCA	5	MCL	0.48	5		No change	59	99	59.4	NA	No change
1,1-DCE	0.5[b]	PQL	400	7	0.02	Yes, lower	1.9	3.2	23,100	NA	Yes, higher
1,2-DCE (cis)	70	MCL	80	70		No change	None	None	None	NA	NA
1,2-DCE (trans)	100	MCL	160	100		No change	33,000	None	32,817	NA	No change
PCE	5	MCL	0.081	5		Yes, lower[a]	4.2	8.85	0.39	NA	Yes, lower
1,1,1-TCA	200	MCL	7,200	200		No change	41,700	None	416,666	NA	Yes, higher
TCE	5	MCL	0.49	5		No change	56	81	6.7	NA	Yes, lower
Vinyl chloride	0.5[b]	PQL	0.029	2[a]	0.02	Yes, lower	2.9	525	3.7	NA	Yes, higher
PCBs	0.04[b]	PQL	0.044	0.5	0.02-0.04	Possibly lower	PQL: 0.04[b]	0.00017	0.00011	0.02-0.04	Possibly lower
1,4-Dioxane[c]	None		4	None			None	None	None		

[a]The ROD states that cleanup level equals drinking water MCLs because they are "sufficiently protective" in accordance with Washington Administrative Code 173-340-720(3)(a). Review of Ecology Implementation Memo No. 1 (WDOE 1993) indicates that the MCLs for 1,2-DCA and PCE would no longer be considered sufficiently protective; nor would the MCL for vinyl chloride. However, vinyl chloride's RG is the PQL, not the MCL.
[b]Source: ROD Table 11-4 (U.S. Navy, USEPA, and Ecology 1998)
[c]The chemical was identified as a potential chemical of concern in the second 5-year review; therefore, no ROD RG was established.

Notes:
ARARs - applicable or relevant and appropriate requirements
DCA - dichloroethane
DCE - dichloroethene

Table 7-1 (Continued)
Groundwater and Surface Water ARARs for OU 1

MCL - maximum contaminant level
µg/L - microgram per liter
MTCA - Model Toxics Control Act
NTR - national toxics rule
PCBs - polychlorinated biphenyls
PCE - tetrachloroethene
PQL - practical quantitation limit
ROD - Record of Decision
TCA - trichloroethane
TCE - trichloroethene

Table 7-2
Groundwater ARARs for OU 2 Area 8

Chemical	Drinking Water Protection						Surface Water Protection				
	ROD Drinking Water Cleanup Level (µg/L)	Basis of Cleanup Level	Current MTCA Method B (µg/L)	Current Federal MCL (µg/L)	Current State MCL (µg/L)	Change in Cleanup Level if established today?	ROD Surface Water Cleanup Level (µg/L)	Basis of Cleanup Level	Current MTCA Method B (µg/L)	Current National AWQC (µg/L)	Change in Cleanup Level if established today?
Metals											
Cadmium	5	Federal MCL	8	5	5	No	8	Marine chronic AWQC	20	8 (C)	No
Chromium III	16,000	MTCA B	24,000	None	None	Yes, higher	160,000	MTCA B	243,000	none	Yes, higher
Chromium VI	80	MTCA B	48	None	None	Yes, lower	50	Marine chronic AWQC	486	50 (C)	No
Chromium (total)	50	State MCL	None	100	100	Yes, higher	None		None	none	NA
Volatile Organic Compounds											
1,1-DCE	7	MCL	400	7	7	No	3.2	National AWQC (HH)	23,000	7,100 (HH)	Yes, higher
1,2-DCE (cis)	70	MCL	80	70	70	No	None		80	none	NA
PCE	5	MCL	0.08	5	5	Yes, lower[a]	8.9	National AWQC (HH)	0.86	3.3 (HH)	Yes, lower
1,1,1-TCA	200	MCL	7,200	200	200	No	42,000	MTCA B	420,000	none	Yes, higher
TCE	5	MCL	0.49	5	5	No	81	National AWQC (HH)	6.7	30 (HH)	Yes, lower

[a]In accordance with Washington Administrative Code 173-340-720(3)(a) and review of Ecology Implementation Memo No. 1 (WDOE 1993), the MCL for PCE is not sufficiently protective when compared to the new MTCA B drinking water value. Therefore, the MCL would no longer be acceptable if a cleanup level were to be established today, i.e., the cancer risk level of the MCL would exceed 1×10^{-5}.

Notes:
ARARs - applicable or relevant and appropriate requirements
AWQC - Ambient Water Quality Criteria
HH - the AWQC based on human ingestion of fish in the water body
C - the AWQC based on chronic marine toxicity

Table 7-2 (Continued)
Groundwater ARARs for OU 2 Area 8

DCE - dichloroethene
MCL - maximum contaminant level
µg/L - microgram per liter
MTCA - Model Toxics Control Act
PCE - tetrachloroethene
ROD - Record of Decision
TCA - trichloroethane
TCE - trichloroethene
NA - not applicable

Table 7-3
OU 1 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current MTCA Method B Value for Surface Water (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
1,1-DCA	800	None	1,600	Not applicable	New value is higher. Risks meet target goals.	Not applicable	Yes	The basis of the ROD value of 800 µg/L is not known. The current MTCA B value is based on an oral reference dose of 0.2 mg/kg-day.
1,1-DCE	0.5 (PQL)	1.9	MTCA B = 400 MCL = 7	23,100	New value is higher. Risks meet target goals.	New value is higher. Risks meet target goals.	Yes	No longer considered a carcinogen by EPA. Revised value is based on noncancer toxicity value (reference dose of 0.05 mg/kg-day).
PCE	5 (MCL)	4.2	MTCA B = 0.081 MCL = 5	0.39	Cancer risk at MCL = 6×10^{-5} (a)	Cancer risk = 1×10^{-5}	Yes	Oral slope factor changed from 0.051 to 0.54 $(mg/kg\text{-}day)^{-1}$.
1,1,1-TCA	200 (MCL)	41,700	MTCA B = 7,200 MCL = 200	416,666	New value is higher. Risks meet target goals.	New value is higher. Risks meet target goals.	Yes	Oral reference dose changed from 0.02 to 0.9 mg/kg-day.
TCE	5 (MCL)	55.6	MTCA B = 0.48 MCL = 5	6.7	Cancer risk at MCL = 1×10^{-5} (a)	8×10^{-6}	Yes	Oral slope factor changed from 0.011 to 0.089 $(mg/kg\text{-}day)^{-1}$.
Vinyl chloride	0.5 (PQL)	2.92	MTCA B = 0.029 MCL = 2	3.7	Cancer risk at PQL = 2×10^{-5} (a)	New value is higher. Risks meet target goals.	Yes	Oral slope factor changed from 1.9 to 1.5 $(mg/kg\text{-}day)^{1}$.

Table 7-3 (Continued)
OU 1 Remediation Goals With Changes in Toxicity Values

[a]The Record of Decision states that cleanup level equals drinking water MCLs because they are "sufficiently protective," in accordance with Washington Administrative Code 173-340-720(3)(a). Review of Ecology Implementation Memo No. 1 (WDOE 1993) indicates that the MCLs for PCE would no longer be considered sufficiently protective, nor would the MCL for vinyl chloride. However, vinyl chloride's RG is the PQL, not the MCL. Because TCE's MCL represents a cancer risk level equal to or below 1×10^{-5}, the MCL for TCE remains protective under MTCA.

Notes:
DCA - dichloroethane
DCE - dichloroethene
EPA - U.S. Environmental Protection Agency
MCL - maximum contaminant level
µg/L - microgram per liter
mg/kg-day - milligram per kilogram per day
MTCA - Model Toxics Control Act
PCE - tetrachloroethene
PQL - practical quantitation limit
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene

Table 7-4
OU 2 Remediation Goals With Changes in Toxicity Values

Chemical	Drinking Water RG (µg/L)	Surface Water RG (µg/L)	Current Value for Drinking Water (µg/L)	Current MTCA Method B Value for Surface Water (µg/L)	Drinking Water Health Risk of the RG Based on New Toxicity	Surface Water Health Risk of the RG Based on New Toxicity	Remedy Is Still Protective?	Reason for Toxicity Revision
Area 8								
Chromium VI	80	50	48	486	Hazard = 2	Not applicable, RG based on protection of marine life	Yes	The reference dose for this chemical was lowered in 1998 (currently 0.003 mg/kg-day).
1,1-DCE	7	3.2	MTCA B = 400 MCL = 7	23,100	New value is higher. Risks meet target goals.	New value is higher. Risks meet target goals.	Yes	No longer considered a carcinogen by EPA. Revised value is based on noncancer toxicity value (reference dose of 0.05 mg/kg-day).
PCE	5	8.9	MTCA B = 0.081 MCL = 5	0.39	Cancer risk at MCL = 6×10^{-5} (a)	Cancer risk = 2×10^{-5}	Yes	Oral slope factor changed from 0.051 to 0.54 $(mg/kg\text{-}day)^{-1}$.
1,1,1-TCA	200 (MCL)	41,700	MTCA B = 7,200 MCL = 200	416,666	New value is higher. Risks meet target goals.	New value is higher. Risks meet target goals.	Yes	Oral reference dose changed from 0.02 to 0.9 mg/kg-day.
TCE	5	81	MTCA B = 0.48 MCL = 5	6.7[b]	Cancer risk at MCL = 1×10^{-5} (a)	1×10^{-5}	Yes	Oral slope factor changed from 0.011 to 0.089 $(mg/kg\text{-}day)^{-1}$.
Area 2								
Vinyl chloride	1 (PQL)	None	MTCA B = 0.029 MCL = 2	Not applicable	Cancer risk at PQL = 3×10^{-5} (a)	Not applicable	Yes	Oral slope factor changed from 1.9 to 1.5 $(mg/kg\text{-}day)^{-1}$.

Table 7-4 (Continued)
OU 2 Remediation Goals With Changes in Toxicity Values

[a]The Record of Decision states that cleanup level equals drinking water MCLs because they are "sufficiently protective" in accordance with Washington Administrative Code 173-340-720(3)(a). Review of Ecology Implementation Memo No. 1 (WDOE 1993) indicates that the MCL for PCE and vinyl chloride would not be considered sufficiently protective. Because TCE's MCL represents a cancer risk level equal to or below 1×10^{-5}, the MCL for TCE remains protective under MTCA.

[b]The basis of the ROD surface water RG of 81 µg/L was the federal AWQC human health-organisms only, which is now 30 µg/L. This change was not due to a change in toxicity assumptions. Risks have been estimated using MTCA B methodology for ease of comparison with OU 1 and because it is likely that a MTCA B level would be selected today as an ARAR, rather than the federal value.

Notes:
DCE - dichloroethene
EPA - U.S. Environmental Protection Agency
MCL - maximum contaminant level
µg/L - microgram per liter
mg/kg-day - milligram per kilogram per day
MTCA - Model Toxics Control Act
PCE - tetrachloroethene
PQL - practical quantitation limit
RG - remediation goal
TCA - trichloroethane
TCE - trichloroethene

Table 7-5
Issues

No.	Issue	Affects Protectiveness	
		Current	Future
Site-Wide			
1	The basis for some remediation goals at the site, including both ARARs and toxicity criteria, have changed and continue to change, with the potential to affect future decisions regarding monitoring and institutional controls requirements.	No[a]	Yes[a]
2	There are infrequent community updates.	No	No
OU 1			
3	Phytoremediation at OU 1 is not as effective as intended by the ROD.	No[b]	No[b]
4	1,4-Dioxane is present in shallow-aquifer and intermediate-aquifer groundwater at concentrations exceeding the current MTCA Method B Cleanup level at OU 1.	No[c]	Yes[c]
5	The data set generated to date indicates that changes to the OU 1 monitoring program may be warranted.	No[d]	No[d]
6	The chromium concentration in the 2009 sediment sample from location MA-11 was higher than typically observed and exceeded the screening level for the first time since 1996.	Yes[e]	Yes[e]
OU 2 Area 2			
7	Based on the data set generated to date, changes to the groundwater monitoring program may be warranted.	No[d]	No[d]
8	The current lowest possible practical quantitation limit for vinyl chloride in groundwater (0.02 µg/L using selected ion monitoring analysis) is not being met by the monitoring program.	No[b]	Yes[b]
OU 2 Area 8			
9	1,4-Dioxane is present in one groundwater monitoring well at OU 2 Area 8 at concentrations exceeding the current MTCA Method B cleanup level.	Yes[f]	Yes[f]
10	Cadmium concentrations in sediment appear to be slowly increasing at OU 2 Area 8.	Yes	Yes[g]

[a]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 bases of remediation goals.
[b]The ROD requirements are being met, conditions are not worse than at the time of the ROD, and the ROD found that conditions at the time of the ROD were protective.
[c]Current concentrations of 1,4-dioxane at OU 1 do not pose a threat to off-site receptors. However, potential future higher concentrations could pose a threat.
[d]Monitoring program changes are recommended to focus data collection on areas that could potentially affect future protectiveness. However, current protectiveness is not called into question by the current monitoring program.
[e]Because the chromium concentration in sediment at MA-11 exceeds the screening level and is the highest measured on site, current and future protectiveness could be affected.
[f]The current single exceedance of the MTCA Method B groundwater cleanup level for 1,4-dioxane at OU 2 Area 2 could affect current and future protectiveness, because the receptor for Area 8 groundwater is surface water, and 1,4-dioxane is persistent in both groundwater and surface water (Mohr 2001).

Table 7-5 (Continued)
Issues

[g]The available evidence, including a favorable bioassay result, potentially indicates that ecological risks may be currently acceptable. Human health is currently protected because there is no complete ingestion pathway. However, additional evaluation is required regarding future ecological and human health protectiveness.

Notes:
ARARs - applicable or relevant and appropriate requirement
µg/L - microgram per liter
MTCA - Model Toxics Control Act
OU - operable unit
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
Site-Wide						
1	In the next revision of the LTM plan and institutional controls management plan, include language that states that the basis of the remediation goal (i.e., ARARs, PQLs, and risk assessment assumptions) must be reviewed prior to any change in monitoring or institutional controls requirements.	NAVFAC NW	Ecology	12/31/2012	Yes	Yes
2	Evaluate ways to improve updates to the community.	NAVFAC NW	Ecology	12/31/2012	No	No
OU 1						
3	Perform the evaluation of natural attenuation and intrinsic bioremediation called for in Section 11.1.6 of the Record of Decision.	NAVFAC NW	Ecology	12/31/2013	No	Yes
4	Add 1,4-dioxane as an analyte for groundwater wells sampled for evaluation under the CRA plan. Revise the CRA plan to incorporate trigger levels for 1,4-dioxane in sentinel wells.	NAVFAC NW	Ecology	12/31/2011	No	Yes
5	In conjunction with EPA, Ecology, and the Suquamish Tribe, revise the LTM plan for OU 1.	NAVFAC NW	Ecology	12/31/2011	No	No
6	In conjunction with EPA, Ecology, and the Suquamish Tribe, develop a SAP to assess chromium concentrations in sediment around location MA-11, including an assessment of chromium concentrations in catch basin solids.	NAVFAC NW	Ecology	12/31/2011	Yes	Yes
OU 2 Area 2						
7	Revise the LTM plan to address potential changes in monitoring.	NAVFAC NW	Ecology	12/31/2011	No	No
8	Use selected ion monitoring analysis to achieve a PQL of 0.02 µg/L for vinyl chloride in water samples.	NAVFAC NW	Ecology	12/31/2011	No	Yes

Table 8-1 (Continued)
Recommendations and Follow-Up Actions

No.	Recommendation/ Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Action: Affects Protectiveness	
					Current	Future
OU 2 Area 8						
9	Include 1,4-dioxane in the analyte list for groundwater and seep samples during the 2011 LTM sampling event. Evaluate the need for additional monitoring or action related to 1,4-dioxane based on 2011 results.	NAVFAC NW	Ecology	12/31/2011	Yes	Yes
10	In conjunction with EPA, Ecology, and the Suquamish Tribe, prepare a SAP for sediment and marine tissue at OU 2 Area 8 and perform an additional ecological risk evaluation and HHRA based on the results of the sampling. A. Prepare SAP. B. Conduct sampling. C. Report sampling results. D. Perform ecological risk evaluation and HHRA.	NAVFAC NW	Ecology	A. 12/31/2011 B. 12/31/2012 C. 12/31/2013 D. 12/31/2014	No	Yes

Notes:
ARARs - applicable or relevant and appropriate requirements
CRA - contingent remedial action
Ecology - Washington State Department of Ecology
EPA - U.S. Environmental Protection Agency
HHRA - human health risk assessment
LTM - long-term monitoring
µg/L - microgram per liter
NAVFAC NW - Naval Facilities Engineering Command Northwest
OU - operable unit
PQLs - practical quantitation limits
SAP - sampling and analysis plan

9.0 CERTIFICATION OF PROTECTIVENESS

The remedy implemented at OU 1, NBK Keyport, is expected to be protective of human health and the environment in the future once intrinsic bioremediation, with possible assistance from phytoremediation, degrades contaminant concentrations to below RGs. In the interim, exposure pathways that could result in unacceptable risks are being controlled and monitored. The conditions and COC concentrations found today in the landfill, marsh, and downstream receptors are similar to those at the time of the ROD, when those conditions were found to not pose unacceptable risks to human health and the environment, as long as exposures were controlled. Current protectiveness should be verified through assessment of chromium concentrations in sediment near location MA-11 to ensure that the chromium concentrations in sediment at this location do not represent discharge conditions different than known at the time of the ROD. Future protectiveness depends on implementing the recommendations of this review (Table 8-1) and will be assessed based on continued monitoring of COC concentrations and trend analysis.

An overall protectiveness determination of the remedy at OU 2 cannot be made at this time because the OU 2 Area 8 protectiveness determination needs to be deferred. The remedy implemented at OU 2 Area 2 is expected to be protective of human health and the environment in the future, once natural attenuation degrades contaminant concentrations to below RGs. In the interim, exposure pathways that could result in unacceptable risks are being controlled and monitored. The conditions and COC concentrations found today in groundwater are similar to those at the time of the ROD, when those conditions were found to not pose unacceptable risks to human health and the environment, as long as exposures were controlled. Future protectiveness depends on implementing the recommendations of this review (Table 8-1) and will be assessed based on continued monitoring of COC concentrations and trend analysis.

A protectiveness determination of the remedy at OU 2 Area 8 cannot be made at this time and will be deferred until further information is obtained. Further information will be obtained by implementing recommendations 9 and 10 in Table 8-1, which call for including analysis of 1,4-dioxane in the 2011 monitoring plan, the development of a sediment and marine tissue SAP, sampling to generate new data, and further evaluation of potential sediment and marine tissue contamination and risk assessment. Based on the time required to develop a SAP, collect and analyze data, and conduct a risk evaluation, a protectiveness determination is not expected to be made until December 31, 2014.

10.0 NEXT REVIEW

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

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APPENDIX A

Site Inspection Checklist

Site Inspection Checklist

I. SITE INFORMATION	
Site name: *NBK, Division Keyport*	**Date of inspection:** *September 17, 2009*
Location and Region: *Keyport, WA, Region 10*	**EPA ID:** *WA1170023419*
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 *Phytoremediation; Sediment and soil removal; tide gate upgrade; groundwater, sediment, and shellfish monitoring; contingent actions*

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

II. INTERVIEWS (Check all that apply)

1. **Navy Staff**

Name	Title	Date	Phone no.
Douglas Thelin	*NAVFAC NW RPM*	*10/9/09*	*360.396.0206*

Problems; suggestions; ☒ Report attached *See Appendix B*

Name	Title	Date	Phone no.
Diane Jennings	*Keyport PAO*	*9/30/09*	*360.396.2699*

Problems; suggestions; ☒ Report attached *See Appendix B*

Name	Title	Date	Phone no.

Problems; suggestions; ☐ Report attached _____

Name	Title	Date	Phone no.

Problems; suggestions; ☐ Report attached _____

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

Agency *Kitsap County Health District*

Contact Janet *Brower R.S.* *SHW Program Manager* *10/30/09* *360.337.5672*

Name Title Date Phone no.

Problems; suggestions; ☒ Report attached *See Appendix B*

Agency *Suquamish Tribe*

Contact *Denice Taylor* *Environmental Scientist* *10/14/09* *360.394.8449*

Name Title Date Phone no.

Problems; suggestions; ☒ Report attached *See Appendix B*

Agency *Ecology*

Contact *Chung Ki Yee* *Environmental Engineer* *10/12/09* *360.407.6991*

Name Title Date Phone no.

Problems; suggestions; ☒ Report attached *See Appendix B*

Contact _____ _____ _____ _____

Name Title Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

3. **Members of the public**

Contact *Shirl Golden* *10/9/09* *360.779.1746*

Name Date Phone no.

Problems; suggestions; ☒ Report attached *See Appendix B*

Contact _____ _____ _____

Name Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

Contact _____ _____ _____

Name Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

Contact _____ _____ _____

Name Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

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
☒ Health and Safety Plan	☐ Readily available	☐ Up to date	☐ N/A

Remarks *Documentation on site is out of date and should be updated*.

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 *$251,552* ☐ Breakdown attached

Total annual cost by year for review period if available

From *FY2005* (Date)	To _____ (Date)	*$263,000* (Total cost)	☐ Breakdown attached
From *FY2006* (Date)	To _____ (Date)	*$366,000* (Total cost)	☐ Breakdown attached
From *FY2007* (Date)	To _____ (Date)	*$310,000* (Total cost)	☐ Breakdown attached
From *FY2008* (Date)	To _____ (Date)	*$301,000* (Total cost)	☐ Breakdown attached
From *FY2009* (Date)	To _____ (Date)	*$284,000* (Total cost)	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: *None*

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A
A. OU 1
1. **Access to landfill and plantations controlled?** ☒ Yes ☐ No Remarks_____
2. **Groundwater wells installed?** ☐ Yes ☒ No Remarks_____
3. **Any activities that could interfere with remedy or monitoring?** ☐ Yes ☒ No Remarks_____
4. **Any permanent workers on landfill?** ☐ Yes ☒ No Remarks_____
5. **Any digging in landfill without dig permit?** ☐ Yes ☒ No Remarks_____
6. **Any disturbance to wetlands?** ☐ Yes ☒ No Remarks_____
B. OU 2
1. **Access to Areas 2 and 8 controlled?** ☒ Yes ☐ No Remarks_____
2. **Groundwater wells installed?** ☐ Yes ☒ No Remarks_____
3. **Any digging without dig permit?** ☐ Yes ☒ No Remarks___*Area 8 - recent asphalt patch for utilities – done under dig permit.*_____
4. **Any residential development?** ☐ Yes ☒ No Remarks_____
C. Site 23
1. **Asphalt paving at Site 23 still present?** ☒ Yes ☐ No Remarks_____
2. **Groundwater wells installed?** ☐ Yes ☒ No Remarks_____
3. **Any digging without dig permit?** ☐ Yes ☒ No Remarks_____

4. **Any land use change?** ☐ Yes ☒ No

Remarks_____

_____

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*___ _____*RPM*_____ ___*360.396.0206*___

Name Title 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. Paved Landfill Surface

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 *See phyotoremediation below*

6. **Alternative Cover (armored rock, concrete, etc.)** ☒ N/A
Remarks_____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
Areal extent_____ Height_____
Remarks_____

8. **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_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent_____
Remarks_____

10. **Monitoring Wells** (within surface area of landfill)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks *Spot-checked during this review. Full review based on monitoring reports*.

B. Surface Water Structures at Paved Landfill

1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident
Areal extent_____ Depth_____
Remarks_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent_____ Type_____
Remarks *Substantial vegetation along west side of paved portion of landfill at OWS discharge, but no ponding reported, no apparent effect on flow from level spreaders*.

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

4. **Discharge Structure** ☒ Functioning ☐ N/A
Remarks_____

C. Phytoremediation

1. **Condition of Trees** ☒ Excellent health ☐ Some apparent health stress
☐ Severe stress observed

Area of most stress_____
Remarks_____
_____

2. **Performance Monitoring**

Type of monitoring *Groundwater elevation and sampling*

Frequency *Semiannual*

Remarks *See text of 5-year review report.*

3. **Effectiveness**

☐ Data indicate effective uptake and metabolism of COCs

☐ Data indicate not effective

☒ Data inconclusive

Remarks *See text of 5-year review report.*

D. Groundwater, Sediment, and Shellfish Monitoring

1. **Monitoring Wells**

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks *Per monitoring reports*_____

2. **Monitoring**

Types of monitoring being conducted:
☒ Groundwater (OU 1 and OU 2) ☒ Sediment (OU 2 Area 8) ☒ Shellfish (OU 2 Area 8)

Frequency *Varies—see text.*

Remarks *See text of 5-year review report.*

3. **Data Trends**

Describe results and trends: *See text of 5-year review report.*

E. Other Remedy Components

1. **Soil and Sediment excavations** ☒ Completed ☐ Not Completed
2. **Contingent Remedial Action Plan** ☒ Completed ☐ Not Completed
3. **Tide Gate Upgrade** ☒ 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 text of 5-year review report.*
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 text of 5-year review report.*
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 text of 5-year review report.*
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. *See text of 5-year review report.*

APPENDIX B

Interview Responses

INTERVIEW RECORD FOR THIRD FIVE-YEAR REVIEW
June 2004 through June 2009
Type 2 Interview – Regulatory Agency
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Janet Brower R.S.
Title: SHW Program Manager
Organization: Kitsap County Health District
Telephone: 360.337.5672
E-mail: browej@health.co.kitsap.wa.us
Address: 345 6th Street, Suite 300,
Bremerton, WA 98337-1866

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
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 Naval Base Kitsap (NBK) Keyport, the Records of Decision (RODs) for OUs 1 and 2, the implementation of the remedies at these OUs, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: My tenure with Health District began in 1998 as SHW Program Manager, to my knowledge we have not had any direct involvement in the Bangor corrective action implementation. I believe that we have copies of the RI/FS for Bangor as we were a repository for documents during the public comment period. However, since then we have not been provided with reports, summaries, or data pertaining to the site. We do routinely interact with Waste Mgt personnel from Bangor, most usually in regards to off-site disposal of soils or debris removed as part of clean-ups. In those cases we would have had approval authority for off-site reuse of non-hazardous waste disposal or reuse.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy components included:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate

- Upgrade and maintenance of the landfill cover
- Long-term monitoring
- Contingent actions for off-base domestic wells
- Institutional controls

Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

3. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the remedy components included:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

4. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

5. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

6. To the best of your knowledge, since June 2004 have there been any new scientific findings that relate to potential site risks and that might call into question the protectiveness of the remedies?

   Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

7. What is your overall impression of the on-going effectiveness of the institutional controls components of the remedies?

Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

8. The phytoremediation component of the OU 1 remedy was expected to require many years to become fully effective. What is your impression of the effectiveness of this remedy component now that the trees have been growing for approximately 10 years?

   Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

9. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

   Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

10. Since September 2000, have there been any complaints, violations, or other incidents related to NBK Keyport installation restoration issues that required a response by your office? If so, please provide details of the events and results of the responses.

    Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

11. To the best of your knowledge, has the on-going program of environmental monitoring at NBK Keyport been sufficiently thorough and frequent to meet the goals of the RODs?

    Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

12. Are you aware of any community concerns regarding implementation of the remedies at NBK Keyport? If so, please give details.

    Response: Since we have not been provided with copies of the 5 year review documents, this agency has no impression with regards any clean up.

13. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

Response: Concerned that as the local public health regulatory agency overseeing Solid Waste, Shellfish and Drinking Water, that we have received so little information regarding this site and ongoing remediation activities.

Deborah Wilson/Seattle/URSCorp
10/09/2009 09:09 PM

To Michael Meyer/Seattle/URSCorp@URSCORP
cc
bcc
Subject Keyport - interview

Michael,

I received a call from Shirl Golden. She completed the form, but was unable to email it. Her comments were to keep the public informed and that the remedy is working except for the copper plating. The community is happy with the way things were conducted and has moved on. Glad to know of another milestone (this 5 yr review) and just keep informed.

Thank You,

Deborah Wilson
Environmental Scientist
URS Corporation
1501 4th Avenue, Suite 1400
Seattle, WA 98101-1616
Tel: (206) 438-2700
Direct: (206) 438-2248
deborah_wilson@urscorp.com

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INTERVIEW RECORD FOR THIRD FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Diane Jennings
Title: Public Affairs Officer
Organization: NUWC Division Keyport
Telephone: (360) 396-2699
E-mail: Diane.Jennings@navy.mil
Address: 610 Dowell Street, Keyport, WA 98345-7610, Code 00P

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
Date: September 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 Naval Base Kitsap (NBK) Keyport, the Records of Decision (RODs) for OUs 1 and 2, the implementation of the remedies at these OUs, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: I worked in as the Environmental Coordinator for NUWC Keyport October 1990 – May 1999, and was involved with the ROD's for both OUs, and the implementation of remedies to the degree they occurred by the time I left. As PAO, I continued as co-chair of the Restoration Advisory Board, which eventually disbanded (I don't recall what year). With the possible exception of co-chairing RAB meetings, I have not been involved in anything since 2004.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy components included:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate
   - Upgrade and maintenance of the landfill cover
   - Long-term monitoring
   - Contingent actions for off-base domestic wells
   - Institutional controls

Response: I've heard the phytoremediation hasn't been as successful as anticipated when chosen. With the care the Navy has taken in making their decisions, I believe they used the best information and science available and made sensible decisions that serve the best interest of the community and environment as well as the Navy.

3. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the remedy components included:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: Same as #2.

4. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: No

5. Are you aware of any violations of the institutional controls requirements at either of the OUs or Site 23 that could impact the protectiveness of this component of the remedies (e.g., unauthorized excavation, unauthorized use of groundwater)?

   Response: No

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

   Response: I don't know

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

   Response: I don't know; I'd be surprised if the answer were no.

8. Do you know of any significant operation and maintenance difficulties with the phytoremediation or tide gate components of the OU 1 remedy that could have impacted the protectiveness of these components of the remedy?

Response: No

9. The phytoremediation component of the OU 1 remedy was expected to require many years to become fully effective. What is your impression of the effectiveness of this remedy component now that the trees have been growing for approximately 10 years?

   Response: I haven't kept up on it and don't know the monitoring results; the information I have is a few years old and was that the phyto wasn't showing the results that had been anticipated.

10. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: Acceptable. I don't think there was a huge impact on the environment due to the groundwater flow directions and no impact to drinking water wells. Natural attenuation was working effectively enough in my opinion.

11. Are you aware of any community concerns regarding implementation of the remedies either OU? If so, please give details.

    Response: No; I believe the community was satisfied with the Navy's actions, and over time lost interest in the Restoration Advisory Board and it eventually disbanded.

12. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at NBK Keyport?

    Response: A community newsletter that lets them know the Navy is still monitoring, that their property and drinking water are still safe, and that we are protecting the sites through institutional controls. This questionnaire in the community would make a lot of people realize that the Navy has not kept them informed of what the results of monitoring have been.

INTERVIEW RECORD FOR THIRD FIVE-YEAR REVIEW
June 2004 through June 2009
Type 5 Interview – Tribal Stakeholder
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Denice Taylor
Title: Environmental Scientist
Organization: Suquamish Tribe
Telephone: 360-394-8449
E-mail: dtaylor@suquamish.nsn.us
Address: P.O. Box 498/ 18490 Suquamish Way/ Suquamish, WA 98392

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
Date: October 14, 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 Naval Base Kitsap (NBK) Keyport, the Records of Decision (RODs) for OUs 1 and 2, the implementation of the remedies at these OUs, 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 familiar with the RODs for OUs 1 and 2, the implemented remedies and the monitoring and maintenance that has taken place since implementation of the remedies. I have been the Suquamish Tribe's representative on these sites since October 2002.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy components included:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate
   - Upgrade and maintenance of the landfill cover
   - Long-term monitoring
   - Contingent actions for off-base domestic wells
   - Institutional controls

Response: Based on long-term monitoring data, there is no evidence that phytoremediation has positively affected groundwater contaminant levels. VOC concentrations in down gradient wells, as well as in the most proximate surface water sample from Marsh Pond (MA12), consistently exceed remediation goals and regulatory criteria for the protection of surface water.

The removal of PCB contaminated sediments from the marsh does not appear to have effectively eliminated the discharge of PCBs to the aquatic environment. Surface water samples collected from seep SP1-1, located at the sediment removal site, have consistently exceeded the remedial goal and regulatory criterion for PCBs.

Other remedy components appear to be functioning as intended.

3. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the remedy components included:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: Area 2 groundwater monitoring indicates that contaminant levels have decreased and generally meet remedial goals.

   Excavation of vadose-zone soil at Area 8 has not been effective in preventing the migration of site-related contaminants to Liberty Bay. Long-term monitoring data demonstrate continuing impact to sediments and clams. This remedy component cannot be said to be protective of either human health or the environment.

4. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: The human health risk assessment performed as part of the last Five Year Review did not address the concerns of the Suquamish Tribe, although these concerns were repeatedly made known to the Navy. ATSDR's most recent evaluation of Area 8 monitoring data has found that levels of several metals, including cadmium, chromium, lead and mercury, exceed levels deemed protective of human health.

The ecological evaluation completed by the Navy in 2009 indicated the potential for adverse impacts to benthic organisms related to cadmium (sediment concentrations > SMS and HQs >1). The Tribe, however, feels that the evaluation did not adequately address all relevant impacts.

The Tribe believes that further investigation and evaluation are warranted. It is likely that additional groundwater control actions are warranted. Sediment remediation may also be needed.

5. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: I receive draft and final monitoring and annual reports and have the opportunity to provide comment. Regular communication regarding resolution of comments and scheduling is limited.

6. What effects have on-going remedy implementation had on the Tribe and the surrounding community?

   Response: The site is within the usual and accustomed fishing area of the Suquamish Tribe. By treaty, the Tribe retains traditional harvest and access rights. The presence of contamination impacts protected resources and limits the Tribe's ability to safely gather and consume fish and shellfish from the area.

7. Are you aware of any Tribal or other community concerns regarding implementation of the remedies? If so, please give details.

   Response: The implementation of remedies at OU 1 and OU 2 Area 8 have not effectively addressed contamination and do not meet remediation goals and regulatory criteria for the protection of surface water. For Area 8, evaluations of potential human health and ecological impacts have not addressed tribal concerns.

   In addition, while it is understood that remediation is a long-term process, some effort should be made to estimate how long it will take for these sites to come into compliance. This is an important measure of remedy effectiveness.

8. The phytoremediation component of the OU 1 remedy was expected to require many years to become fully effective. What is your impression of the effectiveness of this remedy component now that the trees have been growing for approximately 10 years?

   Response: There is no evidence that the trees have significantly affected groundwater contaminant levels 10 years after implementation of phytoremediation.

9. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on this remediation mechanism. Monitored natural attenuation was also listed as a potential alternative to phytoremediation in the OU 1 ROD. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

   Response: On its own, intrinsic bioremediation does not appear to be effective in reducing VOC contamination to levels that meet remedial goals or regulatory levels for the protection of surface water.

10. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: The Memorandum of Agreement between the Department of Defense and the Suquamish Tribe recognizes the Tribe's right to a substantial and meaningful role in the development of remediation efforts at Navy sites within the Tribe's U&A. Remediation and site management decisions need to actively involve the Suquamish Tribe and address tribal concerns regarding treaty-protected rights and resources.

INTERVIEW RECORD FOR THIRD FIVE-YEAR REVIEW
June 2004 through June 2009
Type 1 Interview – Navy Personnel
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Douglas Thelin
Title: Remedial Project Manager
Organization: NAVFAC Northwest
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 Naval Base Kitsap (NBK) Keyport, the Records of Decision (RODs) for OUs 1 and 2, the implementation of the remedies at these OUs, and the monitoring and maintenance that has taken place since implementation of the remedies. Please also describe your involvement since June 2004.

   Response: As Remedial Project Manager for the Keyport sites, I am very familiar with the RODs and have been responsible for implementation of the remedies since before June 2004.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy components included:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate
   - Upgrade and maintenance of the landfill cover
   - Long-term monitoring
   - Contingent actions for off-base domestic wells
   - Institutional controls

Response:

Phytoremediation: The trees are providing some measure of remediation of VOCs in the groundwater at OU1.

Removal of PCB-Contaminated sediments: The removal of the PCB-contaminated sediment was effective as there have been no subsequent PCB detections in clam tissue.

Tide Gate: The tide gate has remained operational and has prevented erosion potentially caused by high tides.

Landfill Cover: The upgraded landfill cover has prevented exposure of landfill contents.

Long-term monitoring: Effective

Contingent Actions: Monitoring has shown that the off-base domestic wells are not affected by OU1 so contingent actions have not been necessary.

Institutional Controls: Effective, no violations of institutional controls have occurred.

3. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the remedy components included:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

Response:

Institutional controls and monitoring at Area 2: Effective, I have reviewed projects requiring excavation at Area 2 to ensure proper control measures were specified. Groundwater contaminant concentrations are close to cleanup levels.

Excavation and off-site disposal of vadose zone soil at Area 8: The soil removal and subsequent paving of the site removed the potential for contact with contaminated soil at the site.

Institutional controls and monitoring at Area 8: Institutional controls have been effective at preventing human contact with contaminated media. Bioassay testing as part of the monitoring indicates that the site poses no environmental risk.

4. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

   Response: In addition to monitoring data and risk assessments, the Navy performed a bioassay test with sediment from Area 8 which indicated that the sediment poses no ecological risk. This all indicates that additional groundwater control actions and investigations are not required.

5. Are you aware of any violations of the institutional controls requirements at either of the OUs or Site 23 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 Keyport.

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

   Response: Inspections of the institutional control components are conducted yearly and reported to EPA and Ecology each September.

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

   Response: Monitoring data has been timely and of acceptable quality. Sampling for OU2 has been sufficiently thorough and frequent to meet the goals of the OU2 ROD. Sampling for OU1 includes both monitoring required by the OU1 ROD to determine protectiveness and when remedial goals have been met, and monitoring associated with phytoremediation performance. This means groundwater and surface water stations are sampled twice a year and groundwater level measurements are taken quarterly. Now that the phytoremediation plantations have been established and we have nearly ten years of data on phyotoremedation's effect on the groundwater, the monitoring program can be scaled back to performing the sampling required by the OU1 ROD.

8. Do you know of any significant operation and maintenance difficulties with the phytoremediation or tide gate components of the OU 1 remedy that could have impacted the protectiveness of these components of the remedy?

Response: During the last five years there have been no significant operational or maintenance difficulties with the phytoremediation or tide gate. Monthly maintenance of the phytoremediation during the growing season, supplemental irrigation in the summer, and yearly application of a systemic pesticide have contributed greatly to the health of the trees in the phytoremediation plantations. The tide gate is maintained quarterly to ensure its proper functioning.

9. The phytoremediation component of the OU 1 remedy was expected to require many years to become fully effective. What is your impression of the effectiveness of this remedy component now that the trees have been growing for approximately 10 years?

   Response: After 10 years, the trees are healthy and are making an unquantified contribution to the remediation of the site. Aquifer conditions appear to prevent the trees from achieving changes in groundwater elevations expected in the OU1 ROD. The aquifer also appears to be unable to provide sufficient water during the dry summer months so supplemental irrigation is needed.

10. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

    Response: Intrinsic bioremediation is also making an unquantified contribution to remediation of the site. Previous discussions with Mr. Dinicola of USGS and reviews of the OU1 analytical data indicates that intrinsic bioremediation is very effective at reducing the high VOC concentrations in the source areas to much lower concentrations where groundwater discharges to the adjacent surface water.

11. Are you aware of any community concerns regarding implementation of the remedies either OU? If so, please give details.

    Response:

12. Do you have any overall comments, concerns, or suggestions regarding the effectiveness of the remedies in protecting human health and the environment at NBK Keyport?

    Response: As noted in the Question 7 response, we need to consider scaling back the monitoring program for OU1 to what is required by the OU1 ROD.

INTERVIEW RECORD FOR THIRD FIVE-YEAR REVIEW
June 2004 through June 2009
Type 2 Interview – Regulatory Agency
Naval Base Kitsap Keyport
Keyport, Washington

Individual Contacted: Chung Ki Yee
Title: Environmental Engineer 3
Organization: Washington State Department of Ecology
Telephone: 360-407-6991
E-mail: cyee461@ecy.wa.gov
Address: 300 Desmond Drive SE, Lacey, WA 98503

Contact made by: Deborah Wilson, URS
Response type: Written, by e-mail
Date: October 12, 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 Naval Base Kitsap (NBK) Keyport, the Records of Decision (RODs) for OUs 1 and 2, the implementation of the remedies at these OUs, 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 familiar with the Records of Decision for Operable Units 1 and 2 and the implementation of the remedies at these operable units. I am the Ecology's staff assigned to provide oversight of cleanup works at NBK Keyport.

2. What is your overall impression of the on-going effectiveness of the components of the OU 1 remedy? For reference, the remedy components included:
   - Phytoremediation at the former landfill using hybrid poplar trees
   - Removal of PCB-contaminated sediments from the marsh
   - Upgrade of the tide gate
   - Upgrade and maintenance of the landfill cover
   - Long-term monitoring
   - Contingent actions for off-base domestic wells
   - Institutional controls

Response: Phytoremediation at the former landfill – Ecology agrees with Navy/URS's conclusion that "phytoremediation is probably having some degree of positive effect on contaminant reduction. At the least, the phytoremediation process does not appear to be impeding or having a negative effect on the naturally occurring biodegradation processes at OU 1." However, in my opinion, phytoremediation is not effective for contaminants in the intermediate aquifer.

Removal of PCB-contaminated sediments – Since implementing the remedial action in 1999, all five Seep SP1-1 water sampling events detected PCBs at concentrations greater than the remediation goal of 0.04 micrograms per liter. The sediment removal action is not effective enabling Seep SP1-1 water to meet the remediation goal.

All other remedy components are working as intended/designed.

3. What is your overall impression of the on-going effectiveness of the components of the OU 2 remedy? For reference, the remedy components included:
   - Institutional controls and groundwater monitoring at Area 2
   - Excavation and off-site disposal of vadose-zone soil at Area 8
   - Institutional controls and monitoring of groundwater, sediments, and shellfish at Area 8.

   Response: Concentrations of volatile organic compounds and metals exceeding cleanup levels are detected in groundwater samples from wells downgradient of the former plating shop (Building 72). The presence of these contaminants 10 years after the excavation and off-site disposal of vadose-zone soil may indicate the presence of residual source materials at the former plating shop area.

   In the 2008 sampling event, concentrations of phenol, cadmium, and mercury exceeding sediment quality standards were found in sediment samples in selected locations (three transects, nine stations) downslope of Seep A and Seep B. Semivolatile organic compounds and metals were found in marine tissue (clam tissue) samples.

   The excavation and off-site disposal of vadose-zone soil is not effective in preventing the migration of contaminants to Liberty Bay.

4. The ROD for OU 2 Area 8 specified that post-ROD sediment and clam tissue monitoring data from the Area 8 beach would be used to evaluate risks to ecological receptors and human health. The risk assessment results were to be used to assess potential additional groundwater control actions, or further investigations. Based on the monitoring data and the risk assessment performed to date, do you believe that additional groundwater control actions or further investigation are warranted?

Response: In *Naval Base Kitsap, Keyport, Operable Unit 2 Area 8 Shellfish Evaluation Health Consultation (draft), September 15, 2009*, Agency for Toxic Substances and Disease Registry concluded "Levels of cadmium, chromium, lead, and mercury in littleneck clams harvested from outfall areas from NBK, Keyport exceeded levels deemed protective of human health." Based this Health Consultation, Ecology believes that further investigation and control actions are warranted.

5. Do you feel well informed about the remediation activities and progress at NBK Keyport? Please elaborate.

   Response: Yes. I have been provided with reports by the Navy when they are available**.**

6. To the best of your knowledge, since June 2004 have there been any new scientific findings that relate to potential site risks and that might call into question the protectiveness of the remedies?

   Response: Please see Response 4.

7. What is your overall impression of the on-going effectiveness of the institutional controls components of the remedies?

   Response: The institutional controls are working as intended/designed.

8. The phytoremediation component of the OU 1 remedy was expected to require many years to become fully effective. What is your impression of the effectiveness of this remedy component now that the trees have been growing for approximately 10 years?

   Response: Please see Response 2.

9. The US Geologic Survey (USGS), on behalf of the Navy, has been conducting intrinsic bioremediation studies at OU 1 to assess the effects of phytoremediation on intrinsic bioremediation. Monitored natural attenuation was also listed in the OU 1 ROD as a potential "fallback" remedy if phytoremediation is determined to be ineffective. Based on your knowledge of the USGS studies, what is your opinion of the effectiveness of intrinsic bioremediation in protecting human health and the environment at OU 1?

   Response: According to studies conducted by the U.S. Geological Survey, USGS concluded redox conditions in the intermediate aquifer remained mildly reducing and somewhat favorable for reductive dechlorination of volatile organic compounds and that biodegradation appeared to be less significant. USGS further concluded natural attenuation alone was not effective enough to meet current numerical remediation goals. This is due to the relatively short distance between the landfill and the adjacent

marsh and the likely presence of non-aqueous phase liquid chlorinated volatile organic compounds beneath the landfill.

High concentration of vinyl chloride measured in intermediate aquifer wells MW1-25, MW1-28, and MW1-39 were measured in 2008 by USGS. These data support that more non-aqueous phase liquid has dissolved into groundwater and into the intermediate aquifer. In my opinion, given the only somewhat favorable conditions for reductive dechlorination of volatile organic compounds and the extremely high concentrations of volatile organic compounds beneath the landfill, intrinsic bioremediation is not effective in controlling the offsite migration of volatile organic compounds from the intermediate aquifer.

10. Since September 2000, have there been any complaints, violations, or other incidents related to NBK Keyport installation restoration issues that required a response by your office? If so, please provide details of the events and results of the responses.

    Response: No.

11. To the best of your knowledge, has the on-going program of environmental monitoring at NBK Keyport been sufficiently thorough and frequent to meet the goals of the RODs?

    Response: Yes for Operable Unit 1. No for Operable Unit 2 (please see Response 3).

12. Are you aware of any community concerns regarding implementation of the remedies at NBK Keyport? If so, please give details.

    Response: No.

13. Do you have any other comments, concerns, or suggestions regarding the effectiveness of the cleanup measures implemented so far in protecting human health and the environment at NBK Keyport?

    Response: No.