FIVE-YEAR REVIEW REPORT FOR HARBOR ISLAND SUPERFUND SITE SEATTLE, WASHINGTON

Prepared by

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

Cami Grandinetti
Cami Grandinetti, **Program Manager**
Remedial Cleanup Program

9/23/15
Date

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Table of Contents

Tables

Figures (Appendix A)

List of Acronyms

AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
BP	BP West Coast Products
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAA	Clean Air Act
CAP	Corrective Action Plan
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	contaminants of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CWA	Clean Water Act
EBAP	Elliot Bay Action Program
Ecology	Washington State Department of Ecology
ENR	Enhanced Natural Recovery
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
EW-OU10	East Waterway Sediments Operable Unit
FS	Feasibility Study
FYR	Five-Year Review
IC	institutional control
IRIS	Integrated Risk Information System
KM	Kinder Morgan Liquid Terminals
LDW	Lower Duwamish Waterway
LSS-OU7	Lockheed Shipyard Sediments Operable Unit
LU-OU3	Lockheed Upland Operable Unit
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
MLLW	mean lower low water
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and Maintenance
OMMP	Operations, Maintenance and Monitoring Plan
ORP	oxidation-reduction potential

OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
ppm	parts per million
POS	Port of Seattle
PRP	potentially responsible party
PSAPCA	Puget Sound Air Pollution Control Agency
RA	Remedial Action
RAO	Remedial Action Objective
RCW	Revised Code of Washington
RD	Remedial Design
RI	Remedial Investigation
RNA	Restricted Navigation Area
ROD	Record of Decision
RPM	Remedial Project Manager
S&G-OU1	Soil and Groundwater Operable Unit
SCO	Sediment Cleanup Objective
Shell	Shell Oil Products
SMA	Site Management Area
SMS	Sediment Management Standards
SQS	Sediment Quality Standard
TBT	tributyltin
TCE	trichloroethylene
TF-OU2	Tank Farms Operable Unit
TPH	total petroleum hydrocarbons
TSS-OU9	Todd Shipyards Sediments Operable Unit
UECA	Uniform Environmental Covenants Act
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
UU/UE	unlimited use and unrestricted exposure
VISL	Vapor Intrusion Screening Level
WAC	Washington Administrative Code
WPCA	Washington Pollution Control Act
WW-OU8	West Waterway Sediments Operable Unit
WWCA	Water Well Construction Act

Executive Summary

This is the fourth Five-Year Review (FYR) for the Harbor Island Superfund (Site) located in Seattle, King County, Washington. The purpose of this FYR is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this statutory FYR was the signing of the previous FYR on September 24, 2010.

The site is divided into seven Operable Units (OUs):

OU No.	Name
01	Soil and Groundwater OU (S&G-OU1)
02	Tank Farms OU (TF-OU2)
03	Lockheed Upland (LU-OU3)
07	Lockheed Shipyard Sediments OU (LSS-OU7)
08	West Waterway Sediments OU (WW-OU8)
09	Todd Shipyards Sediments OU (TSS-OU9)
10	East Waterway Sediments OU (EW-OU10)

Harbor Island is a 420-acre island located in the Duwamish River delta in Elliott Bay in the City of Seattle, Washington. The man-made island was constructed on the Duwamish River delta with the addition of bulkheads and fill placed in the early 1900s. The Harbor Island site has evolved from an industrialized upland area into a complex cleanup site involving both the upland area and the offshore sediment. Contaminated media included soils, sediments, and groundwater. Cleanup for the various OUs of the site has included contaminated soil removal and upland capping, dredging of contaminated sediment, capping contaminated material that remains in place, enhanced natural recovery, and groundwater monitoring. The cleanup goals are defined in the various Harbor Island formal decision documents (Records of Decision [RODs], Explanations of Significant Differences, and state Cleanup Action Plans [CAPs]) for each OU. The site is heavily industrialized and is expected to remain industrialized in the future. There are currently no residences on the island. The entire island and associated sediments are designated as the Superfund site.

A summary of the FYR conclusions for each of the OUs is presented below.

S&G-OU1

The Soil and Groundwater Operable Unit 01 (S&G-OU1) consists of the upland portion of Harbor Island with the exception of the Petroleum Tank Farms and the upland area of Lockheed Yard 1. The selected remedy at S&G-OU1 included excavation of Hot Spot Soils and treatment/disposal off-site, capping of remaining soil with contamination that exceeds cleanup goals, Institutional Controls (ICs), removal and treatment of floating product at Todd Shipyards, and implementation of long-term groundwater monitoring.

Portions of the remedy are functioning as intended by the decision documents. The remaining hot spot at Todd Shipyards has been removed since the last FYR. Light non-aqueous phase liquid (LNAPL) removal continues at the West Shed recovery wells; the east shed recovery wells have been shut down due to a lack of LNAPL. As the LNAPL system at the Todd Shipyards portion of OU1 is systematically shut down, groundwater monitoring as required in the ROD should be implemented to demonstrate that contaminants are not migrating into the marine environment. Groundwater monitoring across the S&G-OU1 indicates that metals are present at concentrations above ROD cleanup levels in groundwater. A lack of spatial or temporal trends in the groundwater data indicate that active migration toward the waterways is currently not occurring. Institutional controls in the form of restrictive covenants are required for the remedy to be fully functional. ICs are required for the seven properties with environmental caps. Only two of these have Uniform Environmental Covenants Act (UECA)-compliant covenants, which are environmental covenants for a property that may prohibit future uses, require ongoing monitoring and remediation, or note protective structures and engineered controls. Annual cap inspections are also required to confirm that the cap integrity has not been compromised; however, not all of the properties consistently submit cap-inspection reports. Changes to applicable or relevant and appropriate requirements (ARARs) and toxicity data since remedy selection do not affect the protectiveness of the remedy because the low permeability cap and ICs prevent exposure to soils with contaminant concentrations above the new standards, and contaminants in groundwater have not been detected at concentrations above the new standards. There were no changes in exposure pathways.

The remedy at the Soil and Groundwater OU1 currently protects human health and the environment because the LNAPL extraction system is actively removing the remaining product and long-term groundwater monitoring indicates that contaminants are not migrating to the waterways. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness and are expected to occur before the next FYR:

- Complete Restrictive Covenants for all capped properties
- Complete annual cap inspections consistently
- Develop a groundwater monitoring program at Todd Shipyards to determine whether or not contamination is migrating to the waterway

TF-OU2

The Tank Farms Operable Unit 02 (TF-OU2) is being managed by the Washington State

Department of Ecology (Ecology) Toxics Cleanup Program under Model Toxic Control Act (MTCA) Cleanup Action Plans (CAPs). The selected remedy at TF-OU2 included excavation of lead and arsenic contaminated shallow surface soil, excavation of total petroleum hydrocarbons (TPH) Hot Spot Soils and treatment/disposal off-site, construction and operation of *in-situ* remedial systems to treat remaining contaminated soil and groundwater, utilization of natural attenuation processes, long-term monitoring, and ICs.

The remedy is performing as intended by the decision documents. Active remediation continues at the BP Plant 1 facility. A groundwater/LNAPL recovery system is located along the shoreline and an SVE system is located inland. Concentrations of contaminants along the shoreline are currently below cleanup levels including the two wells with historical exceedances, AMW-01 and AMW-02. Data trends at these wells also indicate that concentrations are decreasing. The Kinder Morgan facility implemented sulfate land application as a remediation system in Yards B and D in 2013. The Kinder Morgan and Shell facilities use passive free-product recovery at select wells on an as-needed basis. Residual contamination in the area along 13^{th} Avenue SW and well SH-04 area was jointly investigated by Kinder Morgan and Shell. An evaluation of data trends indicates petroleum contamination is contained and that concentrations are decreasing over time. Ecology has agreed that monitored natural attenuation (MNA) is an appropriate remedy at this location which has been successful in reducing petroleum concentrations in groundwater in the immediate area. Several investigations have been completed in the well TX-03A area at the north end of the Shell main terminal. Geochemical data in the area shows elevated dissolved oxygen, oxidation-reduction potential (ORP), and carbon dioxide concentration indicative of biological activity; however, contaminant concentrations do not indicate decreasing trends. Several pilot tests of potential technologies, including air sparging and soil vapor extraction (SVE), were conducted in 2013-2014 and are currently being evaluated for additional remediation in the TX-03A area. Restrictive covenants for BP, Kinder Morgan, and Shell were recorded between the potentially responsible party (PRP) and Ecology as part of each Consent Decree in 2000. Changes to ARARs and toxicity data since remedy selection do not affect the protectiveness of the remedy because ICs prevent exposure to soils with contamination levels above the new standards, and contaminants in groundwater detected at concentrations above the new standards are located in remediation areas. There were no changes in exposure pathways.

The remedy at the Tank Farms OU2 currently protects human health and the environment because active remediation or MNA is treating contaminants. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness and are expected to occur before the next FYR:

- Evaluate full-scale active remediation at the area near well TX-03A and implement additional remediation if determined appropriate by Ecology in coordination with EPA

LU-OU3

The selected remedy at Lockheed Upland Operable Unit 03 (LU-OU3) included excavation of Hot Spot Soils and treatment/disposal off-site, capping of remaining soil contamination exceeding cleanup goals, ICs, and implementation of groundwater monitoring for 30 years.

Portions of the remedy are functioning as intended by the decision documents. The Port of Seattle (POS) redeveloped the Lockheed Uplands property for use as a container cargo marshalling area in 2011. As part of this project, the utility infrastructure was upgraded to protect the LSS-OU7 cap area and eliminate ponding on the upland cap. Groundwater monitoring shows exceedances of ROD cleanup levels exist at the site for metals and tetrachloroethylene (PCE); metals detections are typically sporadic or localized occurrences. PCE concentrations above cleanup levels remain in the northern portion of the site and appear to have an increasing trend. Additional studies conducted since the last FYR (tidal study and porewater sampling) indicate that the waterway is not being impacted. ICs in the form of restrictive covenants are required for the remedy to be fully functional. There is currently no covenant for the property. Annual cap inspections are submitted consistently and show that the cap integrity has been maintained. Changes to ARARs, exposure pathways, and toxicity data since remedy selection do not affect the protectiveness of the remedy.

The remedy at the Lockheed Upland OU3 currently protects human health and the environment because the cap integrity has been maintained and groundwater studies indicate that contaminants are not impacting the waterway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness and are expected to occur before the next FYR:

- Complete Restrictive Covenants for capped areas of the property

LSS-OU7

The selected remedy at the Lockheed Shipyard Sediments Operable Unit 07 (LSS-OU7) included demolition of the existing pier and removal of approximately 6,000 creosote-coated piles, dredging in the open channel area and capping in the nearshore area, and creation of a riparian buffer and a habitat-friendly substrate on top of the capped sediments.

The remedy is functioning as intended by the decision documents as upland sources are not recontaminating the cap. However, there may be off-site sources that are depositing a fine layer of contaminated sediment in the open-channel area. Sediment contaminant concentrations have generally been below cleanup levels. Recent mercury and total polychlorinated biphenyl (PCB) exceedances in the open channel area may be traced to top-down sources of fine-grained sediments; that is, the contaminant exceedances may be traced to sediment from outside sources deposited from suspension onto the cap. The top-down nature of this contamination should be confirmed in future sampling events. The various areas of the sediment remedy have undergone little to no elevation changes since the implementation of the remedy. Groundwater monitoring data show that concentrations of copper, nickel, and zinc exceeding National Recommended Water Quality Criteria (NRWQC) are present along the shoreline. An evaluation of equilibrium partitioning indicates that the cap will not be recontaminated due to the observed levels of contamination in groundwater. Zinc and mercury have been detected in solids collected from the stormwater treatment system that discharges onto the cap. Additional actions (including collection of additional sediment samples at the discharge point) are required to ensure that contaminated sediments are not being deposited on the cap near the discharge point. ICs were not specified in the ROD, but the Operations, Maintenance, and Monitoring Plan (OMMP) requires the PRP to maintain site access and to maintain required ICs, including establishing a U.S. Coast Guard (USCG) Restricted Navigation Area (RNA). The RNA was established in 2012 to protect capped areas. Cleanup standards and exposure pathways have not changed in a way that affects protectiveness.

The remedy at the Lockheed Shipyard Sediments OU7 currently protects human health and the environment because the cap integrity has been maintained and groundwater studies indicate that contaminants are not impacting the waterway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness and are expected to occur before the next FYR:

- Evaluate new BMPs or perform additional actions to ensure that stormwater contaminants are not discharging onto the LSS-OU7 cap
- In future monitoring events, confirm whether or not the recent contamination can be traced to sediment from outside sources deposited from suspension. If sources such as this exist, EPA will work with the PRP for additional investigations to ensure protectiveness.

WW-OU8

The no action ROD for the WW-OU8 presented the basis for the determination that no Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action was necessary at this OU to protect human health or the environment. Site conditions allow for unlimited use and unrestricted exposure. The no action ROD did not include any requirements for institutional controls and did not require long-term monitoring. Since EPA made the decision for No Action, the statutory requirements of CERCLA Section 121 for remedial actions are not applicable and no statutory or policy five-year reviews are required to be undertaken. EPA will review the WW-OU8 in light of data and decisions and new scientific information or methodologies used in the development of the recently completed Lower Duwamish Waterway (LDW) ROD.

The no action ROD allowed for a discretionary review to verify that the sediment continues to pose no unacceptable risks to human health and the environment. EPA is not aware of any new sediment data from WW-OU8 that suggests it is necessary to conduct monitoring at the site. USACE is currently analyzing alternatives for navigation improvements to the East and West Waterways, including potential deepening. Decisions for deepening will be made following the signing of the East Waterway OU10 ROD, projected to be completed after 2017. Based on this information, EPA will re-evaluate sediment PCB concentrations in the West Waterway OU after the East Waterway OU Record of Decision is signed. Therefore, this OU was not evaluated in this FYR.

TSS-OU9

The selected remedy at the Todd Shipyards Sediments Operable Unit 09 (TSS-OU9) included dredging in the open channel area, demolition of certain piers, capping contaminated sediments under the existing piers, and creation of a habitat bench on the surface of a capped nearshore area.

Results from the latest annual monitoring event indicate that the remedy is functioning as intended by the decision documents for both the dredged and capped areas. At the TSS-OU9, contaminated sediments were either dredged to native clean sediments or capped. Both remedial actions prevent exposure to fish and shellfish either by removing the contaminated sediments or by capping contaminated sediments remaining in place and, absent recontamination, should be fully protective over its lateral extent. Sediment samples were not taken in the last five years because there was no evidence of cap erosion. Because the cap remains in place and stable, contaminant exposure to marine organisms is expected to be minimal or non-existent. Applicable areas of the TSS-OU9 have been well-colonized by marine life. Cleanup standards and exposure pathways have not changed in a way that affects protectiveness. No institutional controls were specified in the ROD, subsequent ESDs, or the consent decree (CD) for the TSS-OU9. Specific institutional controls beyond best management practices and review of permit applications through the United States Army Corps of Engineers (USACE) have not been implemented nor has an Institutional Controls Study been completed. ICs need to be implemented and maintained to ensure the long-term function and protectiveness of the remedy.

The remedy at the Todd Shipyards Sediments OU9 currently protects human health and the environment because the cap integrity has been maintained. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness and are expected to occur before the next FYR:

- Collect sediment samples to determine whether recontamination is occurring
- Conduct an IC study to evaluate the need for ICs. If warranted, include ICs in a decision document and implement the ICs

EW-OU10

No ROD has been prepared for this OU. A supplemental Remedial Investigation and Feasibility Study is currently in progress.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Harbor Island		
EPA ID: WAD980722839		
Region: 10	**State:** WA	**City/County:** Seattle/King
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:** 37T		
Author name (Federal or State Project Manager): Ravi Sanga		
Author affiliation: EPA Remedial Project Manager		
Review period: July 2014 – September 2015		
Date of site inspection: February 4, 2015		
Type of review: Statutory		
Review number: 4		
Triggering action date: September 24, 2010		
Due date *(five years after triggering action date)*: September 24, 2015		

Five-Year Review Summary Form (continued)

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Issues and Recommendations Identified in the Five-Year Review:

OU(s): S&G-OU1, LU-OU3	**Issue Category: Institutional Controls**			
	Issue: Appropriate restrictive covenants are not in place for all required properties.			
	Recommendation: Record completed UECA covenants on required properties.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	September 2020

OU(s): S&G-OU1	**Issue Category: Operations and Maintenance**			
	Issue: Cap inspection and maintenance reporting is inconsistent.			
	Recommendation: Submit reports for all cap areas on a consistent basis.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	September 2016

OU(s): S&G-OU1	**Issue Category: Monitoring**			
	Issue: The LNAPL system at Todd Shipyards has been partially shut down, but long-term groundwater monitoring has not started.			
	Recommendation: Develop a groundwater monitoring program at Todd Shipyards to determine whether or not contamination is migrating to the waterway.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	September 2016

<table>
<tr><td rowspan="3">OU(s): TF-OU2</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: Elevated COC concentrations and a lack of decreasing trends indicate that MNA may not be able to reach cleanup levels in the TX-03A area.</td></tr>
<tr><td colspan="4">Recommendation: Evaluate full-scale active remediation at the area near well TX-03A and implement additional remediation if determined appropriate by Ecology in coordination with EPA.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>PRP</td><td>State</td><td>September 2016</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s):
LSS-OU7</td><td colspan="4">Issue Category: Operations and Maintenance</td></tr>
<tr><td colspan="4">Issue: Zinc and mercury have been detected above SCO criteria in solids in stormwater treatment effluent that discharges to the LSSOU cap.</td></tr>
<tr><td colspan="4">Recommendation: Evaluate the new BMPs or perform additional actions to determine whether stormwater contaminants are discharging onto the LSS-OU7 cap.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>PRP</td><td>EPA</td><td>September 2016</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s):
LSS-OU7</td><td colspan="4">Issue Category: Monitoring</td></tr>
<tr><td colspan="4">Issue: Fine-grained sediments collected during the most recent sampling event in the open-channel area have mercury and total PCB concentrations greater than their respective SCOs. A general increase in total fines has been observed over the last five years. It is possible that there is a fine top layer of sediment that has deposited on the open-channel surface from sources outside the LSS-OU7, which may be indicative of recontamination from sediment from outside sources deposited from suspension.</td></tr>
<tr><td colspan="4">Recommendation: In future monitoring events, confirm whether or not that the recent contamination can be traced to sediment from outside sources deposited from suspension. If sources such as this exist, EPA will work with the PRP for additional investigations to ensure protectiveness.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>PRP</td><td>EPA</td><td>September 2017</td></tr>
</table>

OU(s): TSS-OU9	**Issue Category: Monitoring**			
	Issue: An evaluation of sediment chemistry has not been completed since the RA in 2007.			
	Recommendation: Collect sediment samples to determine whether recontamination is occurring.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	September 2020

OU(s): TSS-OU9	**Issue Category: Institutional Controls**			
	Issue: Institutional Controls Study needs to be completed and ICs need to be completed.			
	Recommendation: Conduct IC Study to evaluate the need for ICs. If warranted, include ICs in a decision document and implement the ICs.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	September 2020

Protectiveness Statement(s)		
Operable Unit: S&G-OU1	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Soil and Groundwater OU1 currently protects human health and the environment because the LNAPL extraction system is actively removing the remaining product and long-term groundwater monitoring indicates that contaminants are not migrating to the waterways. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Complete Restrictive Covenants for all capped properties.
- Complete annual cap inspections consistently.
- Develop a groundwater monitoring program at Todd Shipyards to determine whether or not contamination is migrating to the waterway.

Operable Unit: TF-OU2	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Tank Farms OU2 currently protects human health and the environment because active remediation or MNA is treating contaminants. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Evaluate full-scale active remediation at the area near well TX-03A and implement additional remediation if determined appropriate by Ecology in coordination with EPA

Operable Unit: LU-OU3	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Lockheed Upland OU3 currently protects human health and the environment because the cap integrity has been maintained and groundwater studies indicate that contaminants are not impacting the waterway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Complete Restrictive Covenants for capped areas of the property.

Operable Unit: LSS-OU7	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Lockheed Shipyard Sediments OU7 currently protects human health and the environment because the cap integrity has been maintained and groundwater studies indicate that contaminants are not impacting the waterway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Evaluate the new BMPs or perform additional actions to ensure that stormwater contaminants are not discharging onto the LSS-OU7 cap.
- In future monitoring events, confirm that the recent contamination can be traced to sediment from outside sources deposited from suspension.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
TSS-OU9	Short-Term Protective	

Protectiveness Statement:

The remedy at the Todd Shipyard Sediments OU9 currently protects human health and the environment because the cap integrity has been maintained. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Collect sediment samples to determine whether recontamination is occurring.
- Conduct an IC study to evaluate the need for ICs. If warranted, include ICs in a decision document and implement the ICs.

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1. Introduction

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

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

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

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

EPA is the lead agency for developing and implementing the remedy and for conducting this FYR for the Harbor Island Superfund Site (the Site). The Department of Ecology (Ecology), as the support agency representing the State of Washington, has reviewed all supporting documentation and provided input to EPA during the FYR process and is the lead agency for the Tank Farms Operable Unit.

This is the fourth FYR for the Harbor Island Superfund Site. The triggering action for this statutory review is the September 24, 2010, completion of the previous FYR. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site at levels above those that would allow for unlimited use and unrestricted exposure. The Site consists of seven operable units (OUs), all of which are addressed in this FYR. The OU number is a database number used to identify each OU and is for reference only as the official OU name does not include a number. The site layout and OU distinctions are shown in Figure 1 and Figure 2 (see Appendix A for all figures for this document). The following list identifies the operable units in current use:

OU No.	***Name***
01	Soil and Groundwater OU (S&G-OU1)
02	Tank Farms OU (TF-OU2)
03	Lockheed Upland (LU-OU3)
04, 05, 06	No longer considered as operable units
07	Lockheed Shipyard Sediments OU (LSS-OU7)
08	West Waterway Sediments OU (WW-OU8)
09	Todd Shipyards Sediments OU (TSS-OU9)
10	East Waterway Sediments OU (EW-OU10)

Post remedial action activities are occurring at different OUs concurrently. In addition, there are several potentially responsible parties (PRPs) that have interests in particular land parcels on the island and are involved in more than one OU.

2. Site Chronology

Following is a chronological listing of significant events at the Site, both initial site-wide events (Table 1) and subsequent events separated by OU (Tables 2 through 8). The OU chronologies are listed separately because each has its own date for significant events such as signing of the record of decision (ROD).

Table 1. Site Chronology – Harbor Island (Initial Site-Wide Actions)

Event	Date
Initial discovery contamination under CERCLA	01/01/1980
Preliminary Assessment, Site Investigation	03/01/1980
NPL listing, Site-wide	09/08/1983

Table 2. Site Chronology – S&G-OU1

Event	Date
Remedial Investigation/Feasibility Study (RI/FS) start for S&G-OU1	09/07/1988
Record of Decision (ROD) for S&G-OU1 signed	09/30/1993

Event	Date
First Explanation of Significant Differences (ESD)	07/26/1994
Amended ROD issued	01/25/1996
Consent Decree with PRPs for Remedial Design/Remedial Action (RD/RA) for S&G-OU1	08/06/1996
Second ESD issued	09/26/2001
"Hot spot" removals completed	1996 – 2002
T-18 expansion and capping completed	04/2002
Long-term groundwater monitoring started	09/2005
Remaining "hot spot" at Todd Shipyards (Design Set #3) completed	09/2012

Table 3. Site Chronology – TF-OU2

Event	Date
RI/FS for TF-OU2 started	1994
RI/FS completed	1997
Restrictive Covenant for Equilon facility (now owned and operated by Shell Oil Products U.S.) recorded	10/1998
Corrective Action Plan (CAP) for Equilon (Shell)	11/1998
Consent Decree for Equilon (Shell)	04/1999
CAP for GATX facility (now owned and operated by Kinder Morgan Energy Partners)	12/1999
CAP for ARCO facility (now owned and operated by BP West Coast Products)	01/2000
Engineering Design Report for Equilon (Shell)	03/2000
Consent Decree for GATX (Kinder Morgan)	04/2000
Consent Decree for ARCO (BP)	04/2000
Restrictive Covenant for ARCO (BP) recorded	05/2000
Restrictive Covenant for GATX (Kinder Morgan) recorded	06/2000
Engineering Design Report for ARCO (BP)	08/2000
Soils Excavation Completion Report for ARCO (BP)	03/2001
Engineering Design Report for Kinder Morgan (formerly GATX)	06/2001
Soils Excavation Completion Report – Shoreline Manifold and Main Terminal Areas for Equilon (Shell)	02/2002
Soils Excavation and Groundwater Remedy Construction Completion Report for Kinder Morgan (formerly GATX)	11/2002
Groundwater Remedy Construction Completion Report for BP (formerly ARCO)	09/2003
Soils Excavation Completion Report – Main Tank Farm for Shell (formerly Equilon)	11/2004

Table 4. Site Chronology – LU-OU3

Event	Date
Administrative Order issued, RI/FS started	09/14/1990
RI/FS Completed	6/28/1994
ROD signed	6/28/1994
RD/RA start	09/30/1994
Consent Decree for Cleanup	02/27/1995
Construction Complete	12/27/1995
Partial delisting (NPL) for Lockheed Upland Property	11/07/1996
Long-term groundwater monitoring started	10/2005
Terminal 10 Utility Upgrade Project complete	12/2011

Table 5. Site Chronology – LSS-OU7

Event	Date
RI completed for marine sediments	1994
Supplemental RI completed	1995
ROD issued selecting the remedy for the Shipyard Sediments OU, and subdivided the Shipyard Sediments OU into two separate OUs: TSS-OU9 and LSS- OU7	1996
Administrative Order on Consent issued for RD	07/16/1997
First ESD issued	02/22/2002
Second ESD issued	03/31/2003
RD for demolition approved	07/02/2003
Start of Phase 1 RA – pier demolition	07/07/2003
RD for dredging and capping approved	10/25/2003
Completion of Phase 1 construction season	03/10/2004
RD for Phase 2 construction season approved	10/18/2004
Start of Phase 2 RA – dredging and capping of contaminated sediments	10/22/2004
Completion of Phase 2 remedial action	02/04/2005
Long-term groundwater monitoring started	11/2005

Table 6. Site Chronology – WW-OU8

Event	Date
Preliminary Investigation	1984
Storm drain cleanup completed	1989

Event	Date
Initial RI sediment sampling	1990
Sediment RI completed	1993
Sediment FS completed	1994
Supplementary RI sediment sampling	1995
Tributyltin studies initiated	1996
Human Health Risk Assessment for sediments	1998
Tributyltin studies completed	1998
Proposed Plan issued	1998
Updated risk assessment information for West Waterway sediments	2002
No-Action ROD signed	9/11/2003

Table 7. Site Chronology – TSS-OU9

Event	Date
RI for marine sediments completed	1994
Supplemental RI completed	1995
ROD issued selecting the remedy for the Shipyard Sediments OU, and subdivided the Shipyard Sediments OU into two separate OUs: TSS-OU9 and LSS-OU7	1996
ESD issued	12/27/1999
Administrative Order on Consent for RD issued	04/25/2000
ESD issued	04/07/2003
Consent Decree recorded	07/21/2003
RD approved	05/25/2004
Start of on-site construction for building/structures demolition (first phase of TSS-OU9 RA)	07/06/2004
Start of sediment dredging and capping for 2004/5 season.	08/15/2004

Table 8. Site Chronology – EW-OU10

Event	Date
Initial RI Sediment Sampling	1990
Sediment RI completed	1993
Sediment FS completed	1994
Supplementary RI Stage 1 sediment sampling	1995
Supplementary RI Stage 2 sediment sampling	1996

Event	Date
Human Health Risk Assessment for sediments in WW-OU8 (this included seafood tissue samples from East Waterway)	1998
Dredge characterization study for Terminals 18, 25, and 30 completed	1998
Stage 1 maintenance dredging completed	2000
Post dredge monitoring of Stage 1 Area completed	2000
Supplementary RI Stage 3 sediment sampling	2001
12 Areas for Early Removal Action identified	2002
Phase 1 Removal Action of contaminated sediments started	2004
Phase 1 Removal Action of contaminated sediments completed	2005
Settlement Agreement for Final Supplemental RI and FS	2006
Sediment and tissue sampling for Supplemental RI and FS completed	2009

3. Background

3.1. Physical Characteristics

Harbor Island is among the largest man-made islands in the United States and is located approximately one mile southwest of downtown Seattle in King County, Washington. The island lies at the mouth of the Duwamish River on the southern edge of Elliott Bay in Puget Sound. The 420-acre island was created during the dredging of the lower Duwamish River and the creation of the East and West Waterways between 1903 and 1905. The dredge spoils were deposited across the island. Subsequent bulkhead construction and filling has brought the island into its current configuration (Figure 1 and Figure 2). The former Duwamish River channel and surrounding floodplains were filled and graded to form the present-day topography. The present urban and developed shoreline is primarily composed of piers, riprap bank lines, and constructed bulkheads for industrial and commercial use.

The island upland is divided into three operable units; Soil and Groundwater OU01 (S&G-OU1), Tank Farms OU02 (TF-OU2), and Lockheed Upland OU03 (LU-OU3). The island is currently over 90 percent covered with impervious surfaces. The island is within the Seattle City Limits. The closest residential properties to Harbor Island are off the island approximately one-half mile away.

The waterway sediment operable units include the Lockheed and Todd Shipyards sediments and the East and West Waterways. The Lockheed Shipyard Sediment OU 07 (LSS-OU7) consists of contaminated nearshore sediments within and adjacent to the former Lockheed Shipyard property on Harbor Island out to the edge of the steep slope of the West Waterway, which occurs at approximately the minus 36 (-36) foot mean lower low water (MLLW) contour. The Todd Shipyards Sediments Operable Unit 09 (TSS-OU9) consists of contaminated nearshore sediments within and adjacent to the Todd Shipyards property on Harbor Island. Todd Shipyards is located at the northwest corner of Harbor Island and faces Elliott Bay to the north and the West Waterway of the Duwamish River to the west.

The West Waterway Sediments OU 08 (WW-OU8) includes approximately 70 acres of estuarine sediments located in the West Waterway on the western side of Harbor Island. The West Waterway is a dredged navigable channel used extensively for industrial and Port purposes. The waterway consists primarily of subtidal sediments, which remain underwater even at low tides. The shoreline of the West Waterway is predominantly pilings, bulkhead, and riprap. Areas of intertidal sediments along the shorelines adjacent to the WW-OU8 are generally nonexistent. No shoreline public access areas exist in the WW-OU8.

The East Waterway Sediments OU 10 (EW-OU10) consists of the East Waterway adjacent to the east side of Harbor Island and its associated contamination. The bed of the East Waterway is owned by the State of Washington and managed by the Department of Natural Resources. The East Waterway is channelized, has a south-to-north orientation, and is approximately 5,800 feet long and 800 feet wide. The southern 1,500-foot section of the EW varies in width from 225 feet to approximately 130 feet near the West Seattle Bridge. The depth of the East Waterway ranges from 7.2 to 51 feet MLLW. The minimum depth of 7.2 feet MLLW is at the southern end, in the vicinity of the West Seattle Bridge.

3.2. Hydrology

The soils beneath Harbor Island consist of 3 to 18 feet of mechanically and hydraulically placed fill underlain by native alluvium deposited in a fluvial deltaic environment (mudflats) of the Duwamish River delta. The physical characteristics of the fill and the upper portion of the underlying deltaic sediments are often indistinguishable from each other. The native material consists of unconsolidated silty to clean, fine-to-medium sand with discontinuous interbeds of silt and clay. The native material has increasing amounts of the finer grained material with depth. The overlying fill material consists primarily of loose fine-to-coarse sand and ranges in thickness from about 3 to 18 feet. Shallow, unconfined groundwater is first encountered at depths of 2.5 to 11 feet below ground surface (bgs) in the fill unit. Soils are continuously saturated throughout the entire stratigraphic column. The RI identified two hydrostratigraphic units: a freshwater lens floating on a second basal saline water unit. The thickness of the freshwater lens exceeds 85 feet in the center of the island and thins to about 35 to 40 feet near the shoreline. The thickness of the freshwater/saltwater interface at the base of the freshwater lens is generally less than 10 feet at the perimeter of the island and possibly somewhat thicker near the center. The freshwater /saltwater interface is assumed to be a boundary for the groundwater flow because of density differences between freshwater and saltwater.

The RI found that groundwater mostly flows from the interior of the island toward the shoreline; typical of an island setting. Groundwater gradients are steepest along the shoreline and flatten toward the interior of the island. However, a localized groundwater low was present in the south-central interior portion of the island. It is unknown if this groundwater low still exists, since most of the wells used in the RI have been destroyed as part of island redevelopment activities. The RI indicated that the groundwater low was likely associated with the sanitary sewers.

Since the RI, several studies on groundwater flow patterns have been completed at the S&G-OU1 and LU-OU3. A summary of the resulting modifications to the original conceptual model of groundwater flow in the RI is presented in Table 9.

Table 9. Groundwater Flow Conceptual Model Modifications

Original Conceptual Model (1990s)	Modifications
Groundwater behaves as a single hydrostratigraphic unit of freshwater floating on a base of saline water.	A shallow saline water interval has been identified at the margins of the island where bulkheads are not present (or fail to significantly impede flow). Freshwater from the interior of the island discharges below this shallow saline interface.
Recharge occurs primarily through precipitation and infiltration from utility lines.	Recharge has likely decreased substantially due to the increase in impervious surface at Terminal 18.
Groundwater flows mainly outward from the interior of the island in a radial pattern and discharges to the waterways.	The center of the island appears to be drained by a major sewer line, which has caused a groundwater low. Where bulkheads are present, groundwater may discharge below the barrier.
A groundwater low was identified in the southern portion of the island.	The groundwater low (mentioned previously) covered an extensive area along the island's center into the region under the Tank Farms. Due to the removal of most of the monitoring locations in the island center, the extent of the area contributing to this sewer line is unknown.
Groundwater levels are tidally influenced. In general, monitoring wells near the shoreline show a larger influence than interior wells.	Tidal studies by Lockheed indicated that in some areas with bulkheads, the net shallow groundwater flow direction may be toward the interior of the island.

3.3. Land and Resource Use

The island was historically used for commercial and industrial activities including ocean and rail transport operations, bulk fuel storage and transfer, secondary lead smelting, lead fabrication, shipbuilding, and metal plating. Warehouses, laboratories, and offices also existed on the island. The land use on the island is changing from a variety of smaller businesses to large operations: Port of Seattle shipping container handling and storage, bulk fuel storage, and shipbuilding and repair. Marine activities occur around the entire island, and dredging has allowed deep draft (40-foot) vessels to berth along piers on the eastern side of the site. The groundwater has never been used as a domestic water source.

Todd Shipyards, the last remaining shipyard, initiated shipbuilding activities on the island in 1916. Todd Shipyards is currently a ship repair, construction, and conversion facility that services commercial and military vessels ranging in size from cruise ships to tug boats. The shipyard operates three dry docks at Piers 4, 5, and 6 for vessel repair and maintenance. A west sloping building berth is located on the West Waterway of the Duwamish River at Piers 1A and 1 for construction and launching of new vessels. Moorage berths are located along Piers 1, 2, 3, 4, 5, and 6. The existing facilities at Todd Shipyards include bulkheads, riprap protection of buttress fill slopes, pile-supported piers, floating dry docks, a pile-supported building berth, a pile-supported side launching way, and miscellaneous access ramps.

The TF-OU2 area has been utilized for petroleum bulk storage and transfer operations since the 1940s. There are three adjacent tank-farm facilities, separately owned and operated currently by BP West Coast Products (BP), Kinder Morgan Liquid Terminals (KM), and Shell Oil Products (Shell). The tank farms are a terminus of a major northwest fuel pipeline and include 70 large, vertical aboveground tanks and numerous smaller ones that store a variety of petroleum products. Total storage capacity is nearly 100 million gallons. The tank areas are unpaved and enclosed within concrete dykes. Other infrastructure within the facilities includes extensive distribution pipelines (above and below ground), pumping and manifold stations, fuel-transfer terminals for ships, railroad cars, and tanker trucks. In addition are commercial buildings used for storage, offices, and other purposes.

The Harbor Island waterways are located within the boundaries of the federally adjudicated Usual and Accustomed Fishing Area for the Muckleshoot and Suquamish Indian Tribes.

3.4. History of Contamination

The Site has been investigated on numerous occasions beginning in 1980. Based on these studies, Harbor Island was listed on the National Priorities List (NPL) on September 8, 1983, due to elevated concentrations of lead in soil associated with the former lead smelter operations, as well as elevated concentrations of other inorganic and organic substances. The soil on Harbor Island had lead, arsenic, and total petroleum hydrocarbons (TPH) concentrations well above acceptable human health risk levels, which were identified and quantified in the remedial investigation and feasibility studies that have been completed. In addition, spills and leaks of product at the petroleum tank farms have created several areas of localized soil contamination in both TF-OU2 and in S&G-OU1. Active product extraction is occurring both in TF-OU2 and as part of the Todd Shipyards in the S&G-OU1.

General sources of potential contamination to the sediments surrounding Harbor Island were identified as direct discharge of waste, spills, historical disposal practices, atmospheric deposition, groundwater seepage, storm drains, combined sewer overflow systems, and other nonpoint discharges. Sediment contamination of the estuarine environment surrounding Harbor Island may also have resulted from upstream sources.

Shipbuilding and ship maintenance activities at Lockheed Shipyard and Todd Shipyards resulted in the direct disposal of waste into sediments of the West Waterway and Elliott Bay adjacent to the shipyards. Much of this waste is believed to have originated from sandblasting, which is a process used to remove paint and paint preparations. Hazardous substances released from both shipyards include arsenic, copper, lead, mercury, tributyltin (TBT), and zinc, which were additives to marine paints used on ships. Other hazardous substances potentially associated with shipyard activities include polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Other sources of contamination at the Lockheed and Todd Shipyards that may have contaminated sediments include public and private storm drains, nonpoint surface runoff from contaminated soil, direct waste disposal, floating petroleum product on groundwater, and contaminated groundwater. Contaminants in sediments include PCBs, PAHs, TBT, arsenic, copper, lead, mercury, and zinc.

A summary of the major contaminants found at Harbor Island that have been released to the different media in the environment are presented in Table 10.

Table 10. Summary of Contaminants by Media

Soil	Sediments	Groundwater
Lead Arsenic PCBs TPH Trichlorothylene (TCE)	PCBs PAHs Arsenic Copper Lead Mercury TBT Zinc	PAH PCBs Copper TCE Tetrachloroethylene (PCE) TPH (TPH-G, TPH-D, TPH-O, BTEX, cPAHs) Arsenic Lead

3.5. *Initial Response*

An initial EPA inspection in 1982 of the lead smelter facility formerly located on Harbor Island identified lead-contaminated soil, which resulted in the listing of the entire island on the NPL in 1983, including the sediments in the adjacent waterways. The remedial investigation (RI) goal was to examine the nature and extent of the contamination in soil and groundwater and the sediments lying just off-shore. In 1988, the RI began for the upland soil and groundwater part of the site (S&G-OU1). By 1993, the completed Feasibility Study (FS) had identified the type and extent of the soil and groundwater contamination and proposed removal and containment actions.

Significant remedial actions began within TF-OU2 during the early 1990s. Interim remedial systems were installed by facility owners at the time in the two shoreline areas to control release of petroleum to surface water. In 1991, a Memorandum of Agreement between Ecology and EPA established Ecology as the lead agency to oversee and complete cleanup of the TF-OU2. The island-wide RI conducted by the EPA in 1992 included the TF-OU2. Subsequent RIs were conducted under oversight by Ecology for each of the three tank-farm facilities. The RI work identified widespread areas of shallow soil that exceeded screening levels for arsenic and lead. Many localized TPH “hot spots” of various extents where TPH concentrations exceeded screening levels for soil were identified in subsurface soil throughout TF-OU2. There were areas of some free product/sheen on groundwater, and broader areas where dissolved petroleum constituents (TPH; benzene, toluene, ethylbenzene, and xylenes [BTEX]) exceeded screening levels. There were also minor detections of carcinogenic PAHs (cPAHs) and lead in the groundwater. An FS was subsequently performed for each tank-farm facility to determine appropriate cleanup actions.

The first investigation of marine sediments around Harbor Island was completed by EPA in 1988 as part of the Elliott Bay Action Program (EBAP). The nature and extent of contamination in Harbor Island sediments was characterized in an RI Report issued by EPA in September 1994. A Supplemental RI, conducted by a group of PRPs in 1996, further characterized the chemical contamination in Harbor Island sediments and reported results of biological effects tests conducted on sediments in the West Waterway of Harbor Island, which included a few locations in the Todd Shipyard, and became the TSS-OU9.

The shipyard operable units were established because the sediments were identified as distinct from other contaminated sediments at Harbor Island. They are predominantly contaminated with hazardous substances and shipyard wastes (primarily sandblast grit) released by shipbuilding and maintenance operations from Todd and Lockheed.

The initial RI/FS for sediments associated with this Harbor Island OU was performed as fund-lead, with subsequent investigations performed by Respondents pursuant to Administrative Orders on Consent with EPA.

Numerous sediment investigations were conducted in the West Waterway from 1985 through 2000 to identify potential adverse ecological effects and human health risks associated with marine sediments. Studies included surface sediment chemistry, sediment toxicity bioassays, TBT bulk sediment and porewater analyses, TBT laboratory bioaccumulation tests, and crab/sole/perch tissue collection and analysis for the human health risk assessment.

The highest concentrations of chemicals in sediments in the West Waterway were associated with the Shipyard Sediments OU and resulted in a separate ROD for the Lockheed and Todd Shipyards Sediment OUs being signed on November 20, 1996. This ROD divided the Sediment OUs into separate OUs for Lockheed and Todd and describes the basis for taking action with the shipyard sediment due to adverse ecological effects. For the remaining sediments, the results of these studies did not indicate a basis for taking remedial action within the West Waterway, and a No-Action ROD was signed.

In 1996, the Port of Seattle, under EPA oversight, sampled the EW-OU10 as part of a dredging characterization in order to complete dredging as a navigational improvement in East Waterway along Terminals 18, 30, and 25. This characterization revealed areas of the waterway that contained moderate to high levels of contamination and required moderate to high levels of dredging for navigation. In 1999, the U.S. Army Corps of Engineers (USACE) performed maintenance dredging along T-18 (Stage 1 Dredging). As required by the EPA, post dredge monitoring was completed in 2000, which indicated that contamination at depth in the area was higher than expected, although below the Washington State Sediment Management Standards (SMS) chemical cleanup screening level. Based on these findings, EPA decided that additional environmental dredging should be performed under EPA oversight. In 2005, the Port of Seattle, through an agreed order with the EPA, removed 260,000 cubic yards of material. Of that total, 60,000 cubic yards were suitable for open water disposal. A 9-inch variable sand layer was placed over the post dredge surface in order to prevent exposure to benthic organisms from remaining contamination that existed at concentrations above State Sediment Management Standards. Current recontamination monitoring indicates increasing chemical concentrations at levels above State standards. This area will be part of the cleanup decision for the EW-OU10.

3.6. Basis for Taking Action

An assessment of the human health risks at Harbor Island identified people who may incidentally ingest soil or have dermal contact with soil as the population most at risk of adverse health effects. Inhalation was not determined as a significant pathway of exposure to contaminants on the upland of Harbor Island. For the Shipyard Sediments, human health risks resulted from consumption of seafood. The most significant risk was elevated cancer risk from PCBs in fish captured in the Elliott Bay/Duwamish River area. Studies were not specific to the Shipyards, but it is likely that high concentrations of PCBs in sediment in the Shipyards contributed to the elevated cancer risk.

Exposure to contaminants in groundwater was not evaluated because there is no current or foreseeable use of groundwater for drinking water purposes. The entire island is serviced by the City of Seattle public water system, and the majority of groundwater beneath the island is naturally brackish and not suitable for drinking. EPA and Ecology determined that national ambient water quality standards for surface water would apply as an ARAR at the shoreline. For Harbor Island, the surface water ARARs are the marine chronic criteria in the " Water Quality Standards for Surface Waters of the State of Washington" and the human health criteria for consumption of marine organisms in "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; State's Compliance Final Rule."

A habitat evaluation for the upland determined that Harbor Island is unable to sustain a wildlife population or support a functioning wildlife habitat due to the widespread industrial development. Therefore, an ecological risk assessment was not completed for the upland OUs. The ecological assessment for the shipyards indicated biological effects from contaminated sediments on benthic organisms.

The results of these studies did not indicate a basis for taking remedial action with the West Waterway**.**

4. Remedial Actions

4.1. Soil and Groundwater OU1

4.1.1. Remedy Selection

The ROD for the S&G-OU1 was signed on September 30, 1993, and amended in August 1995 and January 1996. Explanations of Significant Differences (ESDs) were signed in July 1994 and September 2001. The remedial action objectives (RAOs) were as follows:

- Protect human health from exposure to contaminants in surface soil that pose a combined risk of greater than $1x10^{-5}$.

- Protect human health from infrequent exposure to contaminants in the subsurface that pose a risk greater than $1x10^{-5}$ for each contaminant. Prevent release of contaminants into the groundwater were they can be transported to the shoreline where marine organisms could be exposed.

- Prevent migration of contaminants to the shoreline where marine organisms could be exposed. Protect human health from consuming contaminated marine organisms which pose a risk greater than $1x10^{-6}$.

The components of the selected remedial action identified in the ROD to be completed for S&G-OU1 are listed below:

- Excavate hot spot soils and treat or dispose off-site. Hot spots are defined as soils with TPH concentrations greater than 10,000 milligrams per kilogram (mg/kg); PCBs greater than 50 mg/kg; and mixed carcinogens with a total risk greater than 1×10^{-4}. TPH hot spot soil, which was determined to be non-dangerous waste, would be disposed of at Roosevelt Regional Landfill in Klickitat County, Washington. PCB and hot spot soil with greater than 10^{-4} risk would be sent off-site for treatment (incineration) or disposed in a hazardous waste landfill.

- Cap exposed contaminated soil exceeding cleanup goals. The cap would consist of low permeability material such as asphalt or concrete. New pavement was required to have a minimum thickness of 3 inches and a maximum permeability of 1×10^{-5} cm/s. Existing asphalt and concrete surfaces that are damaged and located in areas where soils exceed cleanup levels were to be replaced or repaired to prevent infiltration of rainwater.

- Invoke Institutional Controls (ICs). These ICs would include a requirement for long-term maintenance of new and existing caps, warn future property owners of remaining contamination under capped areas on their properties, and specify procedures for handling and disposal of excavated contaminated soil from beneath capped areas if future excavation is necessary.

- Remove and treat floating petroleum product and associated contaminated groundwater at Todd Shipyards.

- Implement groundwater monitoring for 30 years, with review of groundwater trends every 5 years to assess the effectiveness of the selected remedy.

4.1.2. Remedy Implementation

A Consent Decree for the S&G-OU1 was signed on August 6, 1996, and lists the Settling Defendants responsible for implementing the remedies described in the ROD. A certified copy was filed with King County in 1996. The following remedial actions have been completed.

Hot Spot Soils Removal and Capping

All of the Hot Spot Soils that had chemicals of concern (COCs) above on-site containment concentrations have been removed and disposed of off-site or properly treated. In 2003, the Port of Seattle finished expanding their cargo container facility (T18) by acquiring approximately 90 acres within the interior of Harbor Island. Contaminated soils exceeding cleanup criteria on the expansion properties were capped according to the requirements of the Consent Decree. The remaining hot spot at Todd Shipyards was remediated in 2011. See Section 5.1.3 for additional details on this removal.

Institutional Controls

To warn future property owners of the remaining contamination, the Consent Decree required that the Settling Defendants record a certified copy of the Consent Decree in the appropriate King County office. Thereafter, each deed, title, or other instrument conveying an interest in a property included in the S&G-OU1 was required to contain a recorded notice that the property is subjected to the Consent Decree (and any lien retained by the United States) and to reference the recorded location of the Consent Decree and any restrictions applicable to the property. See Section 6.4.4 for the current status of ICs at the site.

Todd Shipyards LNAPL Recovery

Todd Shipyards has been operating a light non-aqueous phase liquid (LNAPL) recovery system within the facility boundaries since 1998. Several system modifications have been completed since start-up including a vacuum-enhancement system installed in 2001 and installation of additional recovery wells in 2005 and 2009.

Long-Term Groundwater Monitoring

The ROD required semi-annual long-term groundwater monitoring at selected wells across Harbor Island for a period of 30 years. Long-term monitoring began in 2005.

4.1.3. System Operation/Operation and Maintenance

Cap Inspections

As part of the ICs, property owners are required to perform annual cap inspections and maintenance to ensure protection of site workers from dermal contact and reduce infiltration from rainwater. Annual cap inspections are required for the following properties: POS, the Dutchman LLC, King County, Harbor Island Machine Works, Duwamish Properties LLC, Union Pacific Railroad (UPRR), and Todd Shipyards . Figure 3 shows the cap areas within the S&G-OU1. The Cap Inspection and Maintenance Plan for the Design Set 1B properties, which include UPRR Parcel A, The Dutchman LLC, King County (formerly Fischer Mills), Harbor Island Machine Works (also referred as Paul M. and Dianne Defaccio), is included in the Capping Remedial Action Implementation Report (1998). The Cap Inspection and Maintenance Plan for the Design Set 2 property, which consists of the Port of Seattle T18, is included in the Design Set No. 2 Capping Implementation Report (2006). The Cap Inspection and Maintenance Plan Todd Shipyards (Design Set No. 3) was prepared in 2012 following completion of the hot spot remediation.

The surface conditions and conditions along structures are the two main components of the inspection. The surface is inspected for cracking, damage, settlement, and standing water. It is assumed that if the top surface of the cap is in an acceptable condition, then the underlying layers are also acceptable. Criteria for maintenance are:

- Less than 3 Inches of Settlement: Patch the area using standard asphalt to restore the area to the original grade.
- Greater than 3 Inches of Settlement: Remove/replace the asphalt and base course, replace sub-ballast and/or ballast, or replace topsoil.

Not all of the property owners submitted annual inspection reports consistently, but those reviewed for this FYR indicate that cap is being appropriately maintained. A summary of the annual inspections and maintenance reports received by EPA is provided in Table 11.

Table 11. Summary of Annual Cap Inspections, S&G-OU1

Property	Year	Issues Needing Repairs	Repairs
POS	2010	Settlement (grids F-12 and F-17), gap at base of damaged bollard (grids D-7 and E-20), missing asphalt (grid F-2)	Information not readily available
POS	2011	Settlement (grids F-12 and F-17), gap at base of damaged bollard (grids D-7 and E-20), missing asphalt (grids F-2, F-3, and F-4)	Information not readily available
POS	2012	Deep divots (grids C-4 and D-7), gap at base of damaged bollard (grids D-7 and E-20), missing asphalt (grid E-12, F-13, F-14, and F-15), asphalt cracks (grids E-23, F-8, F-13, F-16, and F-20)	Information not readily available
POS	2013	Settlement (F-12, F-14, F-19, F-21) Deep divots (grids B-10, B-11, B-12, C-11, C-12, F-17), gap at base of damaged bollard (grids D-7 and E-20), missing asphalt (grid), asphalt cracks (grids A-6, C-7, E-23, F-14, F-16, F-17, F-19, F-21)	Completed, except for divots (B-10, B-11, B-12) and cracks (C-7) which continue to be monitored.
POS	2014	Divots (B-10, B-11, B-12) Plant growth in asphalt (F-3, F-18) Bollard/manhole damage (E-20, F-13, C-6, C-7, D-7, F-9) Standing water (F-3) Asphalt cracks (F-14, F-13, F-16)	To be completed
King County	2010	No Issues	
King County	2012	No Issues. Electrical maintenance required excavation and cap replacement.	
King County	2013	No Issues	

Property	Year	Issues Needing Repairs	Repairs
King County	2014	No Issues	
UPRR	2010	No Issues	
UPRR	2011	No Issues	
UPRR	2012	No Issues	
UPRR	2013	No Issues	
UPRR	2014	No Issues	

Property development since the last FYR within the S&G-OU1 includes construction of two new buildings at the Duwamish Properties LLC property (formerly Lone Star Northwest). As part of the construction, portions of the cap were replaced. Post-construction permeability testing verified that the new cap areas met ROD requirements.

Todd Shipyards LNAPL Recovery

The LNAPL recovery system at Todd Shipyards uses specific-gravity skimmers that are connected to a pneumatically-operated skimmer pump located in each recovery well. The pump withdraws LNAPL from the skimmer inlet and pumps it out to an aboveground storage tank. To induce LNAPL flow, groundwater is extracted separately using electric submersible pumps. The drawdown is set at approximately 1 foot below the typical seasonal low groundwater elevation and is controlled by a transducer set in each well. The extracted groundwater is routed to a central shed where it is treated with carbon prior to discharge to the sanitary sewer.

The original LNAPL system consisted of four recovery wells and a belt skimmer set inside a monitoring well at one location with thick Bunker C type non-aqueous phase liquid (NAPL). Several system improvements have been implemented since operation began in 1998. In April 2001, a vacuum-enhancement system was installed to increase the flow of groundwater and NAPL to the well. The unsaturated soils surrounding each recovery well are put under negative pressure maintained by a blower located in a central shed. The air discharged from the blower contains volatile organic compounds (VOCs) that are treated in a catalytic oxidizer prior to being discharged to the atmosphere. In 2004, the method for extracting groundwater switched from a centrally located jet pump to an independently controlled electric submersible pump to eliminate iron fouling problems. The groundwater treatment system was also switched from an air stripper to liquid phase carbon drums to eliminate iron fouling on the stripper trays.

Figure 4 shows the LNAPL recovery system and monitoring network. Changes to the recovery system have been made since startup. Significant historical changes include:

- In 2005, the existing system was adjusted by discontinuing pumping at FW-2 (LNAPL recovery continued by skimming only) and stopping the recovery of viscous product at

FW-10. Three new recovery wells were installed, FW-15, FW-16, and FW-17, along with a second recovery system shed for two of those wells.

- In 2006, FW-2 and FW-5 ceased recovering LNAPL and the wells were taken off-line.
- In early 2008, FW-15 and FW-17 ceased recovering LNAPL.

Active recovery wells during the last five years include the East Shed recovery wells (FW-3, FW-4, FW-20, and FW-21) and the West Shed recovery wells (FW-17, FW-18, and FW-19). Due to typical maintenance issues, recovery wells are never fully operational. Fully operational is described as: active LNAPL removal, groundwater extraction, and enhanced vacuum operation. System wide shutdowns are periodically encountered due to carbon replacements, treatment system repairs, electrical work, and the collection of quarterly LNAPL thickness readings. The east shed recovery well, FW-4, was shut down in November 2012 with EPA approval due to a lack of LNAPL. The remaining East Shed recovery wells were shut down in 2013, also due to the lack of LNAPL. LNAPL monitoring since this time indicates that LNAPL has not re-accumulated in the well. The PRP is currently seeking EPA approval to officially de-activate these wells and remove the East Shed treatment facility.

Performance monitoring for the LNAPL recovery system is described in the Design Set No. 1A, LNAPL Remediation Report and includes 1) determination of individual well LNAPL recovery rates and cumulative recovery volume, 2) determination of total LNAPL recovery rates and cumulative recovery volume, 3) measuring product thicknesses in the recovery wells and monitoring wells, and 4) determination of the hydraulic capture zone of the recovery system. Recovery rates are calculated on a monthly basis, and product thickness is measured on a quarterly basis. Progress reports are submitted to EPA on a quarterly basis.

In December 2013, the LNAPL monitoring program was revised. Thirteen of the monitoring locations were removed from the program since they were: no longer providing useful information; never had LNAPL or had not contained LNAPL in the last 3 years; had other nearby monitoring locations; LNAPL recovery was complete at the well; or the monitoring location is in disrepair. The current monitoring network is shown on Figure 4.

Long-Term Groundwater Monitoring

Long-term monitoring is required to determine if contaminants are migrating to the shoreline where marine organisms could be exposed and to confirm the performance of the soil remedial actions. Long-term groundwater monitoring has been performed since 2005. The final EPA-approved groundwater monitoring plan was completed in 2009. Reports documenting the monitoring events are submitted to EPA annually.

The monitoring network consists of three components: (1) 14 compliance wells located near the shoreline, (2) 4 early warning wells located inland of the compliance wells, and (3) 2 S&G-OU1

boundary wells where the S&G-OU1 adjoins other OUs. Two interior wells (HI-17 and HI-18) were also sampled from 2009 to 2013. Monitoring locations are shown on Figure 5. Monitoring wells are screened across the main island-wide fresher water zone or second low salinity zone where island-related impacts would have the greatest potential to discharge to adjacent surface water.

4.2. Tank Farms OU2

4.2.1. Remedy Selection

OU-2 is comprised of three facilities (shown on Figure 6):

- BP West Coast Products (formerly ARCO Bulk Fuel Storage Facility Harbor Island). Comprised of Plant 1 and Plant 2.
- Kinder Morgan (KM) Liquids Terminal, Harbor Island (formerly GATX Terminals). Comprised of Yards A through E.
- Shell Oil Products Seattle Terminal, Harbor Island (formerly Equilon Enterprises). Comprised of the Shell Main Terminal and Tank Farm, Shell's North Tank Farm area (located 300 feet north of Shell's Main Tank Farm) and Shell's Shoreline Manifold area (located 1,200 feet north of Shell's Main Tank Farm).

Consent Decrees and associated Cleanup Action Plans (CAPs), which are the Ecology equivalent of EPA RODs, were established with facility owners during 1999 and 2000. Indicator Hazardous Substances identified within the Tank Farms OU included:

- Soil: TPH (shallow and subsurface soil), arsenic (shallow soil), and lead (shallow soil).
- Groundwater: Free product/sheen; TPH gasoline, diesel, and oil range; benzene, toluene, ethylbenzene, xylenes, carcinogenic PAHs, and lead.

Cleanup levels for these substances were established in the CAPs for each facility within the TF-OU2 and were mostly identical to cleanup levels established in the EPA RODs for S&G-OU1 and LU-OU3. The cleanup levels for soil were considered protective of industrial worker exposure. The cleanup levels in groundwater were considered protective of surface water (aquatic organisms in Elliott Bay).

The objectives of the remedial actions were to remove all accessible contaminated soil and to achieve groundwater cleanup levels at the shoreline areas and inland property boundaries.

The selected remedial components included:

- Excavate and remove shallow surface soil (6 inches) in areas exceeding 1,000 parts per million (ppm) lead and/or 32 ppm arsenic.
- Excavate and remove accessible surface and subsurface soil in areas exceeding 10,000 ppm total TPH at identified areas adjacent to the shoreline and inland where a large

release occurred in 1996. Excavate and remove soil exceeding 20,000 ppm total TPH throughout all other inland areas. An overriding consideration regarding excavation of contaminated soils was to avoid any risk to the petroleum storage tanks and pipelines.

- Construct and/or operate *in-situ* remedial systems to treat contaminated soil and groundwater. The systems include free product/groundwater recovery, air sparging, and soil vapor extraction (SVE) components and supplemental active free-product recovery by passive methods in specific wells as needed.
- Utilize natural attenuation processes to reduce contaminant levels in soil and groundwater. This was an inherent part of the remedy for inaccessible contaminated soils left in place to avoid risk to infrastructure.
- Perform long-term groundwater monitoring, examine wells for free product, measure groundwater elevations at wells, and construct seasonal groundwater flow maps. Analyze groundwater samples for contaminants of concern (TPH-G, TPH-D, TPH-O, BTEX, cPAHs, Arsenic, Lead). Also analyze for natural attenuation parameters (DO, ORP, carbon dioxide, methane, ferrous iron, nitrate, sulfate, alkalinity) to evaluate natural attenuation processes.
- Institute Restrictive Covenants. The Restrictive Covenants identified the contamination that existed at each facility, provided for the continued industrial use of the property, prohibited groundwater taken from the property, provided for the safety and notification of site workers, prohibited activities that would release or cause exposure to contamination, provided for continuance of remedial actions given property transference, and provided for Ecology access.

4.2.2. Remedy Implementation

The following remedial actions have been completed at TF-OU2.

Removal of Lead-Arsenic Contaminated Surface Soil

Excavation of near-surface lead-arsenic contaminated soil in areas throughout the main Tank Farm at the Shell facility was completed December 2003 through February 2004. Approximately 2,929 tons of impacted soil were removed and disposed of at the Roosevelt Regional Landfill in Klickitat County, Washington. Soil cleanup standards for lead (1,000 ppm) and arsenic (32 ppm) were achieved throughout this area. A small area of lead-contaminated soil near an oil-water separator at the Shell facility was excavated during October 2001, and approximately 75 tons of impacted soil was removed. Due to structural constraints, lead levels in some subsurface soil remains above the lead standard in this area and it was capped with 3 inches of low-permeability asphalt.

Excavation of near-surface lead-arsenic contaminated soil throughout large areas in B and C Yards at the KM facility was completed April through May 2002. Approximately 11,094 tons of impacted soil was removed and disposed of at the Waste Management Columbia Ridge Landfill and Recycling Facility in Arlington, Oregon. Soil cleanup standards for lead (1,000 ppm) and arsenic (32 ppm) were achieved throughout these areas.

No removal of lead/arsenic contaminated surface soil was required at the BP facility.

Removal of TPH Contaminated Surface and Subsurface Soil

All TPH "hot spots" identified in the original RI work and CAPs have been addressed. A description of the removals is presented below.

Numerous discrete areas of TPH-contaminated soil above established cleanup standards of either 10,000 ppm or 20,000 ppm were identified throughout all three tank farms. The 10,000-ppm standard applied to areas adjacent to surface water (Shoreline Manifold area at the Shell facility and Plant 1 at the BP facility) and in the area of a 1996 release (C Yard) at the KM facility. The 20,000-ppm standard applied to inland areas of the tank farms. Impacted soil with concentrations above applicable standards was mostly removed in these areas and transported to appropriate facilities off-site for treatment or disposal. Some subsurface soil with concentrations above applicable standards remains in most of these areas because of the safety constraints imposed on excavating by existing structures (primarily the aboveground tanks). Three areas of TPH-impacted soil were excavated at the Shell facility. One area was completed near a former underground storage tank (UST) (20,000 ppm standard) during October 2001 (33 tons). Another area was partially completed in the Shoreline Manifold area (10,000 ppm standard) during November 2001 (111 tons). The third area was completed in the Main Tank Farm (20,000 ppm standard) during February 2004 (57 tons).

Seven areas of TPH-impacted soil were excavated at the KM facility during April and May 2002 (32,948 tons total). One area was in B Yard (20,000 ppm standard) and six areas were in C Yard (10,000 ppm standard). Applicable standards were achieved in four of these areas.

Six major areas of TPH-impacted soil were excavated at the BP facility during September and October 2000 (5,205 tons total). Two areas were in Plant 1 (10,000 ppm standard) and four areas were in Plant 2 (20,000 ppm standard). Oxygen-release compound was emplaced in one excavation at Plant 2 to enhance biodegradation.

Complete removal of an area of TPH-contaminated subsurface soil identified by the RI in the Shoreline Manifold area of the Shell facility had been precluded by a run of several large fuel pipelines in the area. During 2006, a new bulkhead was constructed and these pipelines were removed. Eleven borings were done throughout the previously identified area of remaining subsurface soil exceeding the 10,000 ppm total TPH cleanup standard in this shoreline area. The borings were done to determine current remaining TPH contaminant levels in the soil. Analytical results from samples taken in the borings indicated that total TPH contaminant levels had attenuated to below 10,000 ppm throughout 70 percent of the previously-identified area. The attenuation is probably attributable in part to the former remedial system that operated in this area, and also to natural attenuation over a 12-year period. Soil with TPH concentrations remaining above 10,000 ppm (40 cubic yards) was removed during October 2009.

The RI work indicated levels of contamination in the subsurface soil in A Yard of the KM facility exceeding the 20,000 ppm total TPH standard applicable in this inland area. The CAP for the facility required further investigation and excavation of these areas to the extent technically practicable after free product in groundwater had been removed from this area. Over the years, free product has mostly disappeared in the area (to the extent of occasional minor sheens in some wells) through both active and passive product-removal remediation actions. During October 2009, seven borings were advanced to investigate the areas where high levels of TPH were previously indicated in subsurface soils. Results indicated that total TPH levels in soil had attenuated in these areas over a 12-year period to levels well below the 20,000 ppm cleanup standard (all values were below 5,000 ppm). No removal of subsurface soil will be required in this area given the results of the investigation.

Additional soil excavation was completed during upgrades to the Shell facility in 2007, when an array of aboveground fuel piping was removed near Tank 80000. Petroleum contaminated soil was observed in this previously inaccessible area. Nine borings were completed to investigate the extent of the contamination. The contamination was bunker oil apparently from a historical spill. Subsequent excavation removed 16 cubic yards of contaminated soil. Conformation samples indicated remaining soil TPH concentration was below the 20,000 ppm total TPH standard applicable in this area.

Construction and Operation of In-Situ Remedial Systems

A summary of the remediation systems that have operated or are currently operating at TF-OU2 is as follows:

- A free product recovery and vapor extraction system operated at the shoreline in the Shoreline Manifold area of the Shell facility prior to the Consent Decree until 2005 when product was no longer observed and hydrocarbon recovery through vapor extraction declined.
- A point-source free product recovery at the KM facility A and B Yards operated from October 2002 through 2004 when product was no longer observed.
- An air sparge system consisting of 16 sparge wells at the KM facility C Yard operated from October 2002 through August 2004 when groundwater cleanup standards had been achieved and maintained.

- An SVE/air sparge system at the KM facility A Yard started up in 2006 and has operated for several years.
- A free product recovery and vapor extraction system at the bulkhead area of BP Plant 1 has been operating since 1992. The system was expanded in 2003 as a requirement of the CAP to include greater capacity for free product/groundwater recovery and add vapor extraction and air sparging components and continues to operate at present.
- An SVE system at BP Plant 1 southern boundary has been operating since 2008.
- Passive free product recovery is occurring at the KM and Shell facilities.
- Monitored Natural Attenuation (MNA) at 13th Avenue SW at the SH-04 area by Kinder Morgan and Shell.
- Sulfate Land Application at Kinder Morgan implemented in 2013 and 2015 and Yards B and D to enhance biodegradation.

Natural Attenuation

Select wells are analyzed for indicator parameters to evaluate natural attenuation processes. These included dissolved oxygen, ferrous iron, methane, sulfate, sulfide, carbon dioxide. Declining contaminant levels in some wells near remaining areas of subsurface TPH contamination provide evidence that natural attenuation is occurring in these areas.

Groundwater Monitoring

Numerous monitoring wells at the tank farms were in place prior to the Consent Decrees and additional wells were installed afterwards. Monitoring wells throughout the tank farms were regularly examined for free product and/or sampled for the contaminants of concern and natural attenuation parameters. Wells designated for particular monitoring activities are specified in the Groundwater Compliance Monitoring Plan for each facility. Two compliance monitoring wells in the Shoreline Manifold area at the Shell facility and five compliance monitoring wells in Plant 1 at the BP facility are screened in groundwater at depths below the bottom of each bulkhead to monitor possible discharge of contaminants to surface water. Other monitoring wells are screened at the water table.

Institutional Controls

Institutional Controls were required in the form of Restrictive Covenants (now called Environmental Covenants) for each facility and were required to be written and recorded 10 days after the signing of each Consent Decree. The restrictive covenants for BP, KM, and Shell were filed with King County on August 15, 2000, August 30, 2000, and October 5, 2000, respectively.

4.2.3. System Operation/Operation and Maintenance

The engineering design and operating components of each of the three remedial systems described below are documented in Construction Completion Reports and As-Built drawings. The acquisition of appropriate permits is documented. The Operations and Maintenance (O&M) procedures specific to each system are presented in O&M manuals prepared for each system. General system operations and maintenance activities along with the operating and performance parameters for each system are presented in required quarterly reports.

<u>BP Plant 1</u>

The groundwater/LNAPL recovery system, located along the shoreline, was designed to pump shallow groundwater with drawdown extending to the bottom of the LNAPL smear zone, approximately 4 feet in total. Ten wells are currently in operation (see Figure 7). Results of operation show that desired drawdown and hydraulic capture/control are being achieved along the waterfront despite reduction in pumping rates from some wells (Ecology 2014a; see Appendix C). Total recovered LNAPL is estimated at 10,098 gallons.

Recovery wells have experienced pumping rate reductions in recent years, attributed to biological fouling in the shallow aquifer due to high concentrations of iron and sulfate present in the brackish water along the waterfront. Maintenance is performed on the wells and pumps to maintain and improve groundwater capture and to ensure that adequate drawdown is achieved.

Two petroleum-sorbent booms are located and maintained in the West Waterway adjacent to Plant 1 to contain petroleum sheen historically appearing on water. Boom locations for the northern boom and the southern boom, shown as dotted lines in Figure 7, were selected to best contain occasional sheens, likely originating from small cracks and discontinuities in the warehouse foundation or island bulkhead/seawall. The foundation and bulkhead/seawall act as a “hanging” wall, trapping LNAPL while allowing groundwater to flow beneath the base.

The petroleum booms are monitored weekly, at a minimum, for the presence of sheen and integrity, and are replaced as necessary. Sheen monitoring data indicate sheens on the West Waterway are infrequent and minor since startup of groundwater and soil remediation systems along the waterfront in October 2002. Recent sheen monitoring of the southern boom continues with a decreasing trend of sheen presence when compared to previous years. No sheens have been observed in the northernmost boom since February 2009. Recorded sheens occur during periods when the groundwater/LNAPL recovery system is temporarily offline. Sheen observances typically decrease once system operations resume, which indicates that groundwater/LNAPL recovery system operation prevents sheen occurrences, as designed.

An inland Soil Vapor Extraction (SVE) system (see Figure 7) is located south of Plant 1 to treat remaining source areas. To date, the inland SVE has recovered approximately 7,933 pounds of TPH-G. Influent concentrations of TPH-G and benzene in the vapor streams decreased sharply after initial system startup and are generally well below Puget Sound Clean Air Agency (PSCAA) discharge limits of 50 parts per million by volume (ppmv) for TPH-G and 0.5 ppmv for benzene since late 2008. Influent hydrocarbon vapor concentrations are currently below PSCAA treatment thresholds and catalytic oxidation emission control has been discontinued (Ecology 2014a; see Appendix C).

In addition to direct hydrocarbon recovery, the induced airflow associated with SVE enhances biodegradation of residual hydrocarbons in soil. Biodegradation calculations use influent flow rates and carbon dioxide levels above background (atmospheric) to estimate the hydrocarbon mass reduced by enhanced biodegradation. To date, enhanced biodegradation is estimated to have reduced 4,355 gallons of hydrocarbons. Carbon dioxide concentrations are now at atmospheric levels, indicating that the bulk of hydrocarbons available to aerobic biodegradation have been reduced or captured.

BP is planning to install a new seawall in 2015 to enhance seismic stability of the Site and add greater protection for the facilities. The design calls for driven interlocking sheet piling to extend approximately 70 feet below ground surface. This will create a deeper barrier to groundwater exchange with the West Waterway and will likely affect the operation of the groundwater/LNAPL recovery system. Once the new seawall is installed further analysis will be conducted to determine if recovery well modification is warranted.

Kinder Morgan

The Kinder Morgan facility implemented a sulfate land application remediation system in Yards B and D in 2013. Passive free product recovery using absorbent socks is currently performed at select wells. Wells 12, A-4, A-6, A-16, MW-7, MW-9, MW-21, MW-23 and MW-24 (see Figure 8 for well locations) contained absorbent socks until the third quarter 2013. Absorbent socks are now placed in these wells periodically when sheen or product is observed.

Shell

There are currently no active recovery systems at Shell. Passive free-product recovery continues in the Shoreline Manifold area. Hydrophobic socks are installed on an as needed basis. Wells MW-209, MW-210 and MW-212 (see Figure 9 for locations) have had passive recovery in the last five years. In 2012 vacuum extraction of free product was also completed quarterly at wells MW-210 and MW-212.

4.3. Lockheed Upland OU3

4.3.1. Remedy Selection

During the site-wide RI/FS, LU-OU3 was established to allow the Lockheed Martin Corporation to proceed with the cleanup of their property on a different schedule from the rest of the Site. The ROD was signed in 1994. The objectives and selected remedial actions are consistent with the S&G-OU1. The LU-OU3 remedial action objectives were to:

- Protect human health from exposure to contaminants in surface soil that pose a combined risk of greater than $1x10^{-5}$.
- Protect human health from infrequent exposure to contaminants in the subsurface that pose a risk greater than $1x10^{-5}$ for each contaminant. Prevent release of contaminants into the groundwater where they can be transported to the shoreline, where marine organisms could be exposed.
- Prevent migration of contaminants to the shoreline where marine organisms could be exposed. Protect human health from consuming contaminated marine organisms that pose a risk greater than $1x10^{-6}$.

The components of the selected remedial actions outlined in the ROD are listed below.

- Excavate and treat hot spot soils. Hot spots are defined as soils with TPH concentrations greater than 10,000 mg/kg. The TPH hot spot soil will be treated on-site by a thermal desorption system with an afterburner.
- Contain exposed contaminated soil with contaminant levels exceeding inorganic and organic cleanup goals. Containment was achieved with a 3-inch asphalt cap designed to reduce infiltration of rainwater and reduce contaminant migration into the environment. Existing asphalt and concrete surfaces that are damaged in areas where soil contaminant levels exceed cleanup goals were either replaced or repaired. Maintenance of the new and existing caps is required under a Consent Decree for the settling PRPs.
- Invoke ICs that will warn future property owners of the remaining contamination contained under capped areas on this property, require future owners and operators to maintain these caps, and specify procedures for handling and disposal of excavated contaminated soil from beneath capped areas if future excavation is necessary.
- Monitor groundwater quality semi-annually for 30 years, or until it has been demonstrated that groundwater contaminants will not reach the shoreline in concentrations exceeding cleanup goals. The groundwater data will be reviewed every 5 years to assess the effectiveness of the selected remedy.

4.3.2. Remedy Implementation

A Consent Decree for LU-OU3 was signed on December 8, 1994 and the remedial actions were completed on December 27, 1995. The LU-OU3 was partially delisted on November 7, 1996. The Port of Seattle purchased a portion of the property in 1997 (referred to as Terminal 10), and sold the northeastern section to BP/ARCO, who developed it into a fueling station.

Hot Spot Soils Removal and Capping

All of the Hot Spot Soils have been removed and areas with organics and inorganics exceeding soil cleanup goals have been capped.

Institutional Controls

To warn future property owners of the remaining contamination, the Consent Decree required that a certified copy of the Consent Decree be recorded in the appropriate King County office. Thereafter, each deed, title, or other instrument conveying an interest in a property included in the LU-OU3 was required to contain a recorded notice that the property is subjected to the Consent Decree (and any lien retained by the United States) and to reference the recorded location of the Consent Decree and any restrictions applicable to the property. See Section 6.5.4 for the current status of ICs at the site.

Long-Term Groundwater Monitoring

Semi-annual groundwater monitoring has been conducted since 2005. The objective of the program is to monitor contaminants at and down-gradient of source areas.

4.3.3. System Operation/Operation and Maintenance

Cap Inspection

As part of the ICs, annual cap inspections and cap maintenance are required to ensure protection of site workers from dermal contact and reduce infiltration from rainwater. The integrity of the capped areas is inspected by examining them for cracks, breaches, and the presence of vegetation. These methods were presented in the O&M Plan included as Appendix B of the Remedial Action Work Plan (1995).

There are five capped areas at LU-OU3 that require annual inspections (see Figure 10). Maintenance items are completed as necessary to maintain cap integrity. The POS is contractually responsible for repair of damaged capped areas. There have been no reported ponding issues in Cap Area 2 since the completion of the T10 infrastructure project in 2011 (see Section 5.5.3 for additional details). A summary of the annual inspections is presented in Table 12.

Table 12. Summary of Annual Cap Inspections, LU-OU3

Year	Cap Area 1	Cap Area 2	Cap Area 4	Cap Area 5	Cap Area 6
2010	Good condition	Ponded water during wet season, accumulated sediment, cracks with plant growth	Good condition	Good condition	Plant growth in areas previously sealed, overall good
2011	Very good condition (new cap placed during T10 construction)	Very good condition, expanded to include former UST area (new cap placed during T10 construction)	Good condition	Small cracks on seam at northern border, no exposed soil	Good condition, shrubs near fence and moss on cap
2012	Excellent condition	Excellent condition	Good condition	Good condition (cracks sealed)	Good condition, shrubs near fence and moss on cap
2013	Excellent condition	Excellent condition	Good condition, some weeds in previously sealed cracks	Good condition	Good condition, shrubs near fence and along previously repaired seams
2014	Excellent condition	Excellent condition	Very good condition (weeds removed and cracks sealed)	Very good condition	Good condition (weeds removed and area resealed)

Groundwater Monitoring

The Lockheed uplands groundwater monitoring program consists of semi-annual sampling in April (wet season) and October (dry season). The network was designed to monitor specific contaminated areas. Each area has a monitoring well located near the source and a designated down-gradient well to determine if groundwater contaminants are migrating toward the waterway. Reports are submitted semi-annually.

Modifications to the program were made following recommendations in the last FYR that included the addition of select metals as analytes. A tidal study was completed in 2011 to confirm that the well network is appropriate to detect migration of contaminants to the waterway. Average water level elevations showed an inward gradient (flow from the waterway inland) during spring tides and a combination of inward (northern portion of the site) and outward (southern portion of the site) during neap tide. Monitoring wells are located at the shoreline and at the property boundary, thus the monitoring network was determined to be appropriate to detect migration of contaminants.

4.4. Lockheed Shipyard Sediment OU7

4.4.1. Remedy Selection

The Shipyard Sediment ROD was signed on November 30, 1996. This ROD divided the Sediment OUs into separate OUs for Lockheed and Todd. Remedial Action Objectives (RAOs) were developed as a result of data collected during the RI to aid in the development and screening of remedial alternatives to be considered for the ROD. The RAO for the LSS-OU7 is to reduce concentrations of hazardous substances to levels that will have no adverse effect on marine organisms.

The major components of the remedy selected in the ROD include the following:

- All sediment exceeding the State of Washington SMS Cleanup Screening Levels (CSLs) and all shipyard waste will be dredged and disposed of in an appropriate in-water or upland disposal facility. CSLs are the level above which minor adverse effects always occur in marine organisms.
- All sediments exceeding the Sediment Quality Standards (SQS) of the SMS will be capped with a minimum of 2 feet of clean sediment. SQS corresponds to a level which has no acute of chronic adverse effects on marine organisms.
- Specification of design criteria for acceptable habitat and to prevent future recontamination.
- Institution of long-term monitoring and maintenance of the remedy.
- The extent of dredging of contaminated sediments and waste under piers at the LSS-OU7 will be determined during remedial design based on cost, benefit, and technical feasibility.

Subsequent to the ROD, pre-remedial design studies for the LSS-OU7 better defined the nature and extent of contamination within the OU. The results of these studies indicated that certain elements of the ROD needed to be amended. The February 12, 2002, ESD summarized the sediment characterization data, specified details regarding the dredge and cap remedy, and defined abrasive grit blast. The March 7, 2003, ESD: established confirmation sampling values for contaminants to be used in distinguishing contaminants characteristic of the West Waterway from contamination associated with the LSS-OU7; summarized the long-term monitoring, maintenance, and operational parameters; and identified the disposal option for contaminated sediments dredged from the LSS-OU7 identified as requiring upland disposal.

4.4.2. Remedy Implementation

In an Administrative Order on Consent (AOC) signed with EPA on July 16, 1997, Lockheed Martin agreed to perform the Remedial Design (RD) for implementing the remedy in conformance with the ROD as modified by the two ESDs. The RD was approved in parts as follows:

- For demolition of the wooden piers and piles — RD approved on July 2, 2003.
- For first season dredging and capping — RD approved on October 25, 2003.

- For second season dredging, capping, and habitat enhancement — RD approved on May 25, 2004.

A Consent Decree (CD) between EPA and Lockheed was court-approved on July 23, 2003, under which Lockheed would perform the Remedial Action (RA) and pay past costs for cleaning up the site.

The RA was conducted in two phases. Phase 1 was completed on March 10, 2004, and Phase 2 was completed on February 4, 2005. The first phase of remedial construction efforts was focused on pier demolition and dredging of contaminated sediments. The second phase consisted of dredging, capping, and habitat enhancement.

The major components of RA were the following:

- Replace the existing deteriorated bulkhead wall so the upland soils will remain stable during and after remedial activities. This included pier and timber bulkhead removal and dredging adjacent to the bulkhead.
- Remove all existing pier structures including timber piling and portions of the existing shipway structures from aquatic areas of the site while maintaining the stability of the site.
- Dredge contaminated sediments from the channel and slope areas of the LSS-OU7 while maintaining stable slopes and critical habitat elevations.
- Design the dredge prisms and constructed slopes such that they will be constructible.
- In the Channel Area, remove the depth of sediment that has contaminant levels exceeding SQS criteria and construct a berm to support the Slope Area and maintain critical habitat elevation.
- Perform post-dredge sediment verification sampling and analysis to confirm achievement of SQS in the Channel Area.
- In the Slope Area, limit post-remediation changes of critical habitat elevations (i.e., between -4 to 8 feet MLLW) from that of the existing condition while accommodating a 5-foot-thick cap.
- Construct an on-site mitigation area.
- Create intertidal habitat with clean soil in the vicinity of Pier 10 to mitigate habitat losses resulting from the partial filling of the South Shipway.
- Cap the Slope Area such that the cap will provide: chemical and physical isolation of the underlying contaminated sediments; protection of the chemical isolation portion of the cap from bioturbation and erosional forces; and a final cap surface that is compatible with marine organisms.
- Limited dredging and a sand cover boundary line along the offshore perimeter of the site (as a placeholder concept pending the results of further characterization in this area) to provide partial removal, coverage, and enhanced natural recovery of contaminated off-

site sediments located adjacent to the site; and a final substrate surface that is habitat compatible for marine organisms.

The LSS-OU7 was subdivided into eight Site Management Areas (SMAs) for the purposes of remedial design and action, with SMA 1 referred to as the Channel Area and SMAs 2 – 7 collectively referred to as the Slope Area. The Channel (or unobstructed open water) Area, SMA 1, is the area running the length of the piers, outward from the pier face to the edge of the steep slope of the West Waterway at approximately -36 feet (MLLW). The enclosed water behind Pier 9 is identified as SMA2. This is also an unobstructed area of open water that is bounded by the bank or bulkhead on one side and pier structures on two sides. SMAs 3, 5, and 7 designate sediment areas under the pier structure. Sediments under the shipways are designated as SMAs 4 and 6. Shipways are ramps that are used to move ships out of the water. These ramps contain decking like the pier structures and are held up by closely spaced pilings. SMAs 2 through 7 are collectively referred to as the Slope Area. During this remedial action, 119,064 tons of contaminated sediments were dredged and transported to an approved upland facility for disposal.

Capping was implemented using approximately 100,000 cubic yards of capping material including the cap layer, toe buttress riprap, armor riprap, filter layer, armor layer, and fish mix.

Eight sediment samples were collected from the post-dredge surface of the channel area (SMAs 1 through 7) to evaluate compliance with the design criteria. All analytical results were compared to the SQS chemical criteria to evaluate compliance. Three samples exceeded the SQS for PCBs only. Three other samples exceeded the SQS for a combination of COCs. Table 13 summarizes the nature and locations of exceedances and the corresponding remedial action.

Table 13. Nature and Locations of Exceedances and Corresponding Remedial Action at LSS-OU7

Sampling Location	SQS Compliance Criteria	Sampling Results	Remedial Decisions
SED-200	PCBs – 12 mg/kg	PCBs – 13mg/kg	Pass – no further action
SED-201	PCBs – 130 µg/kg	PCBs – 146.5 µg/kg	Enhanced Natural Recovery (ENR)
SED-202		No exceedances	Pass – no further action
SED-203	As – 57 mg/kg LPAH – 370 mg/kg HPAH – 960 mg/kg PCB – 12 mg/kg	As – 73.4 mg/kg LPAH – 1620 mg/kg HPAH – 1937 mg/kg PCB – 21 mg/kg	Enhanced Natural Recovery (ENR)
SED-204	As – 57 mg/kg Cu – 370 mg/kg Zn – 960 mg/kg Hg – 0.41 mg/kg PCB – 12 mg/kg	As – 127 mg/kg Cu – 829 mg/kg Zn – 585 mg/kg Hg – 0.618 mg/kg PCB – 20 mg/kg	Enhanced Natural Recovery (ENR)
SED-205		No exceedances	Pass – no further action

Sampling Location	SQS Compliance Criteria	Sampling Results	Remedial Decisions
SED-206	PCBs – 12 mg/kg	PCBs – 18 mg/kg	Pass – no further action
SED-207	As – 57 mg/kg Cu – 370 mg/kg Zn – 960 mg/kg Hg – 0.41 mg/kg LPAH – 370 mg/kg	As – 139 mg/kg Cu – 553 mg/kg Zn – 912 mg/kg Hg – 1.32 mg/kg LPAH – 1341 mg/kg	Enhanced Natural Recovery (ENR)

The remedial action for portions of the Channel Area, represented by samples SED-201, 203, 204, and 207, failed to meet the cleanup levels for several COCs. In these areas 6 inches of sand was added to the sediment surface, i.e., Enhanced Natural Recovery (ENR). At location SED-200 where there was an exceedance of PCBs only, no actions were taken because the exceedances were minor and were below the 90th percentile for PCBs present in the West Waterway based on bioassays.

Water quality monitoring during in-water remedial action was conducted. Visual turbidity monitoring was performed during demolition of over-water structures, and both intensive and routine water quality monitoring were performed during dredging and barge dewatering and filling/capping operations. Results of these monitoring events indicate that water quality remained within marine quality standards throughout the monitored events.

A Tribal Fishing Coordination Plan (Fish Coordination Plan) was developed by Lockheed in consultation with EPA and affected Indian Tribes. There are two Treaty Indian Tribes that have reserved fishing rights in the lower Duwamish River including the area of the Lockheed sediment remediation. The Muckleshoot and Suquamish cooperatively fish in these waters. Because in-water demolition, dredging, and capping activities would be occurring at the same time that Tribal fishing would be occurring, a Tribal Fishing Coordination Plan was developed jointly with the affected Tribes and Lockheed. The objectives of the Fish Coordination Plan were to:

- Reduce the potential for conflicts between in-water construction operations and tribal fishing through effective communications and schedule planning.
- Rapidly address any fishing equipment damaged as the result of construction operations within or adjacent to the site area.
- Coordinate future construction activity (as practical) to reduce potential for further damage to fishing equipment.

According to the Fish Coordination Plan, ongoing communications between the Lockheed contractors and the Tribes successfully minimized conflicts between in-water construction and tribal fishing activities despite a high level of fishing activity and record catches in the West Waterway.

Remedial activities were conducted as planned, and cleanup goals were obtained for the first phase of the remedial action. EPA conducted a final inspection on March 7, 2005. The final inspection concluded that construction had been completed in accordance with the remedial design plans and specifications and did not result in the development of a list of incomplete tasks for the remedial action.

4.4.3. System Operation/Operation and Maintenance

The Operations, Maintenance, and Monitoring Plan (OMMP) was approved on September 28, 2006, for LSS-OU7. The goals of the OMMP are to ensure that the remedial actions continue to be protective of the environment. The specific goals are to ensure that:

- The sediment cap continues to isolate toxic concentrations of previously identified COCs in the underlying sediments from marine biota and other biological receptors.
- The sediment cap and the previously dredged open channel area do not become recontaminated with COCs from the underlying sediments or from the uplands adjacent to the LSS-OU7.

The LSS-OU7 is divided into the following five areas based on characteristics or function (see Figure 11):

- Slope Area.
- Open Channel Area.
- Beach Area.
- Mitigation Area.
- Riparian Area.

The OMMP requires visual inspections, hydrographic and topographic surveys, and sediment and groundwater monitoring for COCs. Monitoring results will be used to assess cap integrity, sediments quality, and source control. Detailed tasks and procedures are described in the OMMP.

<u>Visual inspections</u> of the riparian buffer, Mitigation Area, and the Beach Area are conducted at a very low point in the tidal cycle, approximately -3 feet.

<u>Hydrographic surveys</u> are evaluated to assess the stability of the Slope Area and Open Channel Area. Each survey involves creation of a bathymetric map. Isopachs are produced by comparing results from previous and current bathymetric maps. The isopach illustrates changes in the bathymetry from one year to the next.

<u>Topographic surveys</u>, also used to evaluate stability, involve the creation of a topographic contour map of the Beach Area of the sediment cap and the Mitigation Area. Isopachs are

produced by comparing results from previous topographic surveys with the current survey. The isopach illustrates changes in the topography from one year to the next.

Sediment samples are taken and analyzed for COCs to assess the potential toxicity of surface sediments. Sediments remaining in the LSS-OU7 must be protective of the environment. Sediment grab samples are taken to evaluate sediment toxicity in the Open Channel Area, Slope Area, and Beach Area. Sediment traps were placed to evaluate deposition of contamination from the West Waterway. Therefore, if sediment contaminant levels were found to exceed the SQS, EPA could determine whether the contamination was from cap failure or waterway deposition.

There is a limited amount of sediment trap data. Within 2 years of placement, all sediment traps were lost, probably due to boat activity.

Monitoring wells were installed along the bulkhead on the land side. Results from analyzing groundwater were to be used to assess the quality of the groundwater entering the West Waterway from Harbor Island.

Remedial action at the LSS-OU7 was completed on February 4, 2005. The OMMP was implemented immediately after the completion of the remedial action to gather monitoring data that would serve as a baseline against which future monitoring results would be compared. The final topographic and hydrographic surveys of the remedy were taken on February 28, 2005. These surveys demonstrate that the cap met design specifications and will serve as a baseline against comparison to future OMMP surveys.

Since August 2006, five surface (0-10 cm) sediment samples each have been collected annually (excluding 2011 and 2013) from the open-channel area and the beach area (Figure 11). Hydrographic surveys of the slope area and the open-channel area and topographic surveys of the beach area and mitigation area were last conducted in 2010. The next hydrographic surveys for these areas are scheduled to be completed in 2015. Visual and photographic surveys of the beach area, mitigation area, and riparian area are conducted annually and documented in the annual operation, monitoring, and maintenance reports.

4.5. West Waterway Sediments OU8

4.5.1. Remedy Selection

The No Action ROD for the WW-OU8 (September 11, 2003) presented the basis for the determination that no CERCLA action was necessary at this OU to protect human health or the environment. Site conditions allow for unlimited use and unrestricted exposure. The no action ROD did not include any requirements for institutional controls and did not require long-term monitoring. Since EPA made the decision for No Action, the statutory requirements of CERCLA

Section 121 for remedial actions are not applicable and no statutory or policy five-year reviews are required to be undertaken.

The EPA Region will, however, conduct a discretionary review consistent with the following language reproduced herein from the No Action ROD for the WW-OU8:

> *Excerpt 1: "For the West Waterway OU, EPA has determined that no action is necessary to protect public health or welfare or the environment. No CERCLA action is necessary because environmental investigations and site-specific risk assessments found that chemical concentrations in marine sediments within the operable unit do not pose unacceptable risks to human health and the environment. A five-year review for the Harbor Island site will be performed for all OUs. As part of the five-year review process, EPA may authorize monitoring of the OU to verify that the sediment continues to pose no unacceptable risks to human health and the environment."*
>
> *Excerpt 2: "As part of the five-year review process, EPA may require and/or conduct monitoring at the site to verify that sediment continues to pose no unacceptable risks to human health and the environment."*
>
> *"In addition, for the following reasons, EPA expressly determines that the No Action decision in the ROD with respect to PCBs will be revisited if information gathered from dioxin-like PCB congener analyses undertaken for the Lower Duwamish Waterway Superfund site indicate that similar analyses are warranted for the West Waterway OU to ensure protectiveness of human health and the environment. This determination is based on the following circumstances, and is in addition to EPA's normal capacity to re-open site decisions whenever new information suggests EPA should do so to ensure adequate protection of human health and the environment:*
>
> - *The West Waterway OU is contiguous with and down river from the Lower Duwamish Waterway (LDW) site.*
> - *EPA believes that sources of PCBs found in West Waterway OU may include the LDW site.*
> - *All West Waterway OU PCB data utilized for this decision have been evaluated by the total PCB or Aroclor method.*
> - *In the future, environmental samples from the LDW site will be analyzed for dioxin-like PCB congeners, as set forth in the December 20, 2000, LDW RI/FS AOC and attached SOW.*
>
> *EPA commits to review West Waterway OU in light of LDW data and decisions and new scientific information or methodologies at a future time."*

At the time of the ROD, there were no PCB congener data for the West Waterway OU, and none have been collected to date.

As detailed above, EPA stated that the "No Action decision in the ROD with respect to PCBs will be revisited if information gathered from dioxin-like PCB congener analyses undertaken for the LDW Superfund site indicate that similar analyses are warranted for the West Waterway OU to ensure protectiveness of human health and the environment." Because EPA determined for the LDW site that the estimated excess cancer risk for the seafood consumption scenarios is similar for dioxin-like PCB congeners and total PCBs[1], similar analyses of dioxin-like PCB congeners are not warranted for the West Waterway OU and sampling will not be conducted.

Also, as detailed above, EPA committed to review PCB data in the West Waterway OU in light of LDW data and decisions. The LDW Record of Decision was signed on November 21, 2014. The Selected Remedy for the LDW site includes the following information for remediation of subtidal sediments[2]:

- The Remedial Action Level is 12 ppm-oc total PCBs for the top 10 cm (4 inches) in areas where natural recovery is predicted to occur [identified as Recovery Category 2 ("Recovery is Less Certain") and 3 ("Recovery is Predicted")]. [Note: The LDW remedial action level of 195 ppm-oc total PCBs for the top 60 cm would not be relevant to the West Waterway OU because that RAL is applied only in potential vessel scour areas (and none exists in the West Waterway OU).]
- The ENR Upper Limit is 36 ppm-oc total PCBs for the top 10 cm in Recovery Category 2 and 3 areas. Existing RI/FS studies suggest that the West Waterway OU environment is similar to Recovery Category 2 and 3 areas, as defined in the LDW ROD.
- The PCB cleanup level in the LDW ROD is 2 µg/kg dw, to be achieved as a site-wide average (95% upper confidence level on the mean) through natural recovery 10 years after completion of cleanup to the RALs.

The most recent waterway-wide sediment sampling event occurred over 20 years ago in 1995. All surface-sediment samples from that even passed the biological criteria (sediment toxicity bioassays) in Ecology SMS. In 2002, EPA summarized all PCB data and concluded:

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[1] EPA notes that the LDW RI Baseline Human Health Risk Assessment (November 12, 2007; Table B.5-64) indicates that the estimated excess cancer risk for the seafood consumption scenarios (Adult Tribal, Reasonable Maximum Exposure) is similar for PCB TEQs/Congeners ($1x10^{-3}$) and total PCBs ($2x10^{-3}$). The LDW analysis indicates that the lack of these PCB congener data in the West Waterway OU do not appear to result in any significant underestimation of risk; thus, EPA believes that any review for the West Waterway OU would focus on total PCBs.

[2] As detailed in the RI and ROD, the West Waterway OU is comprised of subtidal sediments (any intertidal sediments in the waterway are located outside the boundaries of the West Waterway OU (e.g., within the Lockheed and Todd Shipyard Sediment OUs).

> "Using different units for the same data set, total PCB sediment concentrations ranged from 0.29 ppm-oc to a maximum of 39.6 ppm-oc (RI/FS study) and 87.9 ppm-oc (1995 study). The median of total PCB sediment concentrations was 6.9 ppm-oc (RI/FS study) and 17.7 ppm-oc (1995 study). These total PCB concentrations were calculated using one-half the detection limit for Aroclors reported as undetected."

EPA is not aware of any new sediment data from the sediments of the West Waterway OU that suggest it is necessary to conduct monitoring at the site to verify that sediment continues to pose no unacceptable risks to human health and the environment.

In 2014, the U.S. Army Corps of Engineers (USACE) issued a Notice of Preparation (November 7, 2014), which documented that USACE is analyzing "alternatives for navigation improvements to the East and West Waterways of Seattle Harbor, including potential deepening of these waterways. Initial alternatives include deepening the East and West Waterways up to -55 feet mean lower low water (MLLW)." There is the potential for sediment sampling and/or dredging to occur in the future.

The EW ROD will be completed after 2017. Currently EPA is evaluating remedial alternatives. Decisions of channel deepening for both the EW and WW will be made following the signing of the EW ROD.

The no action ROD allowed for a discretionary review to verify that the sediment continues to pose no unacceptable risks to human health and the environment. EPA is not aware of any new sediment data from WW-OU8 that suggests it is necessary to conduct monitoring at the site. USACE is currently analyzing alternatives for navigation improvements to the East and West Waterways, including potential deepening. Decisions for deepening will be made following the signing of the East Waterway OU10 ROD, projected to be completed after 2017. Based on this information, EPA will re-evaluate sediment PCB concentrations in the West Waterway OU after the East Waterway OU Record of Decision is signed. This OU will not be evaluated further in this FYR.

4.6. Todd Shipyards Sediments OU9

4.6.1. Remedy Selection

The Shipyard Sediment ROD, which includes the Todd Shipyards Sediment Site, was signed on November 30, 1996. RAOs were developed as a result of data collected during the Remedial Investigation to aid in the development and screening of remedial alternatives to be considered for the ROD. The single RAO for the TSS-OU9 is to reduce concentrations of hazardous substances to levels that will have no adverse effect on marine organisms.

The major components of the remedy selected in the ROD include the following:

- All sediment exceeding the chemical contaminant screening level of the State of Washington SMS and shipyard waste will be dredged and disposed of in an appropriate in-water or upland disposal facility.
- All sediments exceeding the SQS of the SMS will be capped with a minimum of 2 feet of clean sediment.
- Specification of design criteria for acceptable habitat and to prevent future recontamination.
- Institution of long-term monitoring and maintenance of the remedy.
- The extent of dredging of contaminated sediments and waste under piers at the TSS-OU9 will be determined during remedial design based on cost, benefit, and technical feasibility.

Subsequent to the ROD, pre-remedial design studies for the TSS-OU9 better defined the nature and extent of contamination within the OU. The results of these studies indicated that certain elements of the ROD needed to be amended. EPA issued an ESD on December 27, 1999. The purpose of the ESD is to designate the Todd Shipyards Site as an independent operable unit identified as the TSS-OU9 and to redefine the boundary of the OU identified in the November 1996 ROD based on additional information gathered during two remedial design investigations associated with this OU.

On April 7, 2003, EPA issued a second ESD. The primary changes documented in this ESD were to:

- Further define the selected remedial action for the under-pier areas.
- Establish confirmation numbers characteristic of contamination present in the West Waterway for the purpose of defining the TSS-OU9 boundary.
- Adjust the TSS-OU9 boundary based on the use of confirmation numbers.
- Summarize the long-term monitoring, maintenance and operational requirements for TSS-OU9.
- Define “predominantly abrasive grit blast”.
- Identify the disposal option.

4.6.2. Remedy Implementation

In an AOC signed with EPA on April 25, 2000, Todd Shipyards agreed to perform the RD for implementing the remedy in conformance with the ROD as modified by the 1999 ESD. The RD was approved by EPA on May 25, 2004. A CD between EPA and Todd was court-approved on July 21, 2003, under which Todd would perform the RA.

The RA was conducted in two phases. Phase 1 was completed at the end of February 2005, and Phase 2 was completed in February 2007. The first phase of remedial construction efforts was focused along the north end of the TSS-OU9 and included pier demolition, dredging, and disposal of contaminated sediments and capping. The activities for this phase were initiated on July 5, 2004, and were completed on February 25, 2005. The major components of this phase of the RA were the following:

- Completed demolition and disposal of side-launch shipways located along the Northeast Shoreline of SMA 1 and Pier 2 located in SMA 8.
- Completed dredging and disposal of contaminated sediment and shipyard debris in SMAs 1, 2, 3, 4, and 5, located on the north side of the Todd property.
- Completed placement of in-water fill, including reconstruction of the Northeast Shoreline slope in SMAs 1 and 2; filling of subtidal depressions in SMAs 3, 5, and 7; and placement of boundary sand in SMAs 1 and 5.
- Completed placement of under-pier cap material at Pier 4 North, Pier 5, Pier 6, and Pier 6 Platform.
- Initiated, but did not complete, dredging and disposal of contaminated sediment in SMAs 7, 8, and 9.

During this period, 166,192 cubic yards of contaminated sediments were dredged and transported to an approved upland facility for disposal.

Under-pier capping was implemented at Piers 4N, 5, 6 and 6P using special equipment consisting of a throwing conveyor mounted on a series of modular floats, a barge-mounted derrick crane, and a series of flat-decked material barges. A total of about 150,000 square feet were capped.

Placement techniques, using the throwing conveyor, were developed through implementation of a test program that took place in SMA 2, on the eastern side of Pier 6. Results of diver surveys of the underwater areas capped during the test program verified that the placement equipment and techniques met all specified criteria. The design criteria for capping under pier structures with was to place 1 foot (average thickness) of sand under piers with timber piling and to place 3 feet (average thickness) for pier structures supported by concrete piling. The capping test at Pier 6, a timber-supported pier, was considered by EPA to be a worst case test because Pier 6 has a much greater density of piles than concrete pile supported piers.

A total of 45 sediment samples were collected from the post-dredge surface of SMAs 1-7 to evaluate compliance with the design criteria. Two of these samples were submitted for bioassay testing and evaluated for compliance using the SMS biological criteria. One of the bioassay locations did not pass the SMS biological criteria; this area has been addressed by placement of a permanent sediment cap. The remaining 43 samples were compared to the SQS chemical criteria to evaluate compliance. Six of these samples exceeded the SQS for mercury only (see Table 14).

Table 14. Confirmation Sampling Locations, Results, and Remedial Action for Samples Exceeding the Compliance Criteria at TSS-OU9

SMA	Sampling Location	SQS Compliance Criteria (mg/kg)	Sampling Results (mg/kg)	Remedial Decisions
SMA-1	TSP-01-01	Hg – 0.41	Hg - 0.068	None
SMA-2	TSP 02-06	Hg – 0.41	Hg – 0.71	Enhanced Natural Recovery (ENR)
	TSP-02-08	Hg – 0.41	Hg – 0.48	Enhanced Natural Recovery (ENR)
SMA-3	TSP-03-02	Hg – 0.41	Hg – 0.85	Enhanced Natural Recovery (ENR)
	TSP-03-06	Hg – 0.41	Hg – 1.04	Enhanced Natural Recovery (ENR)
	TSP-03-07	Hg – 0.41	Hg – 0.66	Enhanced Natural Recovery (ENR)

Water quality monitoring during in-water remedial action was conducted. Visual turbidity monitoring was performed during demolition of over-water structures and intensive and routine water quality monitoring was performed during dredging and barge dewatering and filling/capping operations. Results of these monitoring events indicate that water quality remained within marine quality standards throughout the monitored events.

A Fish Coordination Plan was developed by Todd in consultation with EPA and affected Indian Tribes. There are two Treaty Indian Tribes that have reserved fishing rights in the lower Duwamish River including the area of the Todd sediment remediation. The Muckleshoot and Suquamish cooperatively fish in these waters. Because in-water demolition, dredging, and capping activities would be occurring at the same time that Tribal fishing would be occurring, a Tribal Fishing Coordination Plan (Fish Coordination Plan) was developed jointly with the affected Tribes and Todd. The objectives of the Fish Coordination Plan were to:

- Reduce the potential for conflicts between in-water construction operations and tribal fishing through effective communications and schedule planning.
- Rapidly address any fishing equipment damaged as the result of construction operations within or adjacent to the site area.
- Coordinate future construction activity (as practical) to reduce potential for further damage to fishing equipment.

According to the Fish Coordination Plan, ongoing communications between the Todd contractors and the Tribes successfully minimized conflicts between in-water construction and tribal fishing activities despite a high level of fishing activity and record catches in the Waterway.

Remedial activities were conducted as planned, and cleanup goals were obtained for the first phase of the remedial action. EPA conducted a pre-final inspection on March 7, 2005. The pre-final inspection concluded that construction had been completed in accordance with the remedial design plans and specifications and did not result in the development of a list of incomplete items for the first phase of remedial action.

Remedial construction activities for Phase 2 started on July 5, 2005, and all remedial action construction activities for the TSS-OU9 were completed in spring of 2006. The second phase of remedial construction efforts was focused along the west side of the OU, and included pier demolition, dredging and disposal of contaminated sediments, and capping.

The major components of Phase 2 RA were the following:

- Dredging in SMA 6, SMA 8 (where the initial overburden dredging was conducted in 2004), and SMA 9.
- Demolition of Pier 4S.
- Construction of habitat bench in SMA 6.
- Capping below Piers 1, 2P, 3, and outer reaches of building ways.

4.6.3. System Operation/Operation and Maintenance

An OMMP for the TSS-OU9 was approved by EPA on October 22, 2007 after the completion of the remedial action. The goals of the OMMP are to ensure that the remedial actions continue to be protective of human health and the environment. The specific goals are to ensure that:

- The sediment cap continues to isolate toxic concentrations of previously identified COCs in the underlying sediments from marine biota and other biological receptors.
- The sediment cap and the previously dredged open channel area do not become recontaminated with COCs from the underlying sediments or from the uplands adjacent to the TSS-OU9.

For the OMMP, the TSS-OU9 was divided into four areas based on characteristics or function (see Figure 12). They are the:

- Under-Pier Capped Area.
- Northeast Shoreline Sediment Cap.
- Western Shoreline Habitat Bench.
- Open Water Dredged Area.

Monitoring (physical integrity monitoring) will occur at the Under-Pier Capped Areas, the Northeast Shoreline Sediment Cap, and the Western Shoreline Habitat Bench in Year 1, 2, 4, and 9 after construction of the remedy to compare to the Year 0 monitoring observations. Visual surveys will be conducted to assess:

- Physical integrity monitoring of under-pier cap areas, with contingencies for maintenance of the caps and potential sampling for COCs in areas adjacent to the piers if erosion of cap material has occurred.
- Physical integrity monitoring of the riprap along the Northeast Shoreline in SMA 2 to ensure stability of the sediment cap, with contingencies for maintenance of the cap if erosion of cap material has occurred.
- Physical integrity monitoring of the habitat bench along the Western Shoreline in SMA 6 to ensure the stability of the habitat mix substrate, with contingencies for maintenance of the habitat mix substrate if erosion of this material has occurred.

Early warning standards were developed to signal potential cap failure. Observations of complete erosion of the sand cap along a transect would trigger additional action to assess the extent of erosion and if necessary additional remedial actions. Detailed tasks and procedures are described in the OMMP. Evaluation of sediment chemistry is not required by the OMMP, and has not been completed since the remedial action was completed in 2007. It is recommended that sediment samples be collected to evaluated cap recontamination potential.

Post-construction sediment sampling and survey data were used to verify that the completed remedial action (dredging and capping) met design specifications. These data were also used to establish a baseline (Year 0) against which future monitoring results would be compared.

The TSS-OU9 Year 4 physical integrity monitoring survey was conducted from October 24 – 27, 2011. The physical integrity monitoring was performed by divers at the under-pier capped areas, the Northeast Shoreline Sediment Cap, and the Western Shoreline Habitat Bench to determine if the integrity of the capped material or habitat mix placed during the remedial action has been maintained, and to document conditions following the remedial action and the baseline (2007) and Year 1 (2008) and Year 2 (2009) monitoring surveys. Divers completed visual observations at 20 of the 21 transects shown in Figure 12; transect 12, located in the middle of Pier 4N, was not monitored during the survey due to safety concerns. Detailed diver observations and comments (documented on audio and video recordings) were made at 10-foot increments along each transect. Results of the survey are discussed in Section 6.8.1.

4.7. East Waterway Sediments OU10

A ROD has not been completed for the East Waterway Sediments. The current schedule calls for the signature of this ROD after 2017.

In 2004–2005, the Port of Seattle conducted a non-time-critical removal action for highly contaminated sediments on the East Waterway. The removal action was implemented under the authority of an Action Memorandum (2003). The following actions were completed under the Action Memorandum:

- Dredging 180,000 cubic yards of contaminated sediment unsuitable for open-water disposal and 67,000 cubic yards of sediment suitable for open-water disposal.
- Dewatering sediments not suitable for open-water disposal at an upland staging area and disposing of the dewatered sediments at an upland landfill.

In 2005, it was determined that the dredging did not reach SQS sediment standards after sediment removal so a 6-inch layer of clean sand was placed over the surface to protect benthic organisms from residual contaminants. Recontamination monitoring in 2006, 2007, and 2008 revealed the presence of PCBs and mercury above sediment management standards. A supplemental remedial investigation and feasibility study is underway.

Until a remedial action has been selected in a ROD, there will be no further evaluation of this OU in the FYR.

5. Progress Since the Last Review

5.1. Soil and Groundwater OU1

5.1.1. Protectiveness Statement from Last Review

The protectiveness statement from the last FYR states:

> *The remedy at the S&G OU is protective of human health and the environment in the short-term because a cap is in place to prevent exposure to contaminated soil and limit leaching of soil contaminants. However, in order for the remedy to be protective in the long-term, appropriate restrictive covenants must be recorded, cap inspections and maintenance must be completed annually, LNAPL removal must be continued at Todd Shipyard, and the groundwater monitoring program must be modified and coordinated with groundwater monitoring programs for the other upland OUs.*

5.1.2. Status of Recommendations and Follow-up Actions from Last Review

The status of previous recommendations at the S&G-OU1 is presented in Table 15.

Table 15. S&G-OU1 Status of Recommendations from the 2010 FYR

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
1	1. Cap Inspection and maintenance reporting is inconsistent and PRPs have not been identified for all capped areas of the site.	1. Submit reports for all cap areas on a consistent basis.	Steering Committee	EPA	9/28/2010	Ongoing	
1	2. Appropriate Restrictive covenants are not in place for all required properties.	2. Record restrictive covenants on required properties and negotiate UECA covenants.	Steering Committee	EPA	9/28/2011	Ongoing	
1	3. Hot Spot containing heavy petroleum exists on eastern portion of Todd property.	3. Investigate the Hot Spot and evaluate remedial alternatives.	Todd Shipyard	EPA	9/28/2011	Complete	October 2011
1	4. Cyanide is detected sporadically across the site. Currently analyzing for total and available cyanide, both of which have reporting limits above the cleanup goal for cyanide.	4. Determine the appropriate analytic method and reporting limits for cyanide to determine if waterway is being impacted.	EPA	EPA	9/28/2011	Complete	June 2011
1	5. Groundwater flow in the vicinity of HI-17 has not been confirmed.	5. Assess the groundwater flow near HI-17, which may include a tidal study.	Steering Committee	EPA	9/28/2012	Complete	April 2010
1	6. Long-term groundwater monitoring network may require modification.	6. Modify the long-term groundwater monitoring network.	Steering Committee	EPA	12/31/2011	Complete	September 2010
1	7. Five-Year Review sampling event identified several constituents that should be included in the groundwater monitoring analyte list.	7. Include analyses for PCE at HI-7, bis (2-ethylhexyl) phthalate at HI-5.	Steering Committee	EPA	12/31/2011	Complete	September 2013
1	8. A potential relationship between constituent concentrations and tidal cycle may exist.	8. Consider the tidal cycle in future sampling events.	Steering Committee	EPA	12/31/2011	Complete	June 2011

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
1	9. ROD groundwater cleanup levels may not be protective of marine sediments.	9. Verify that ROD groundwater cleanup levels are protective of marine sediments.	EPA	EPA	9/28/2015	Complete	NA
1	10. Groundwater monitoring and groundwater flow analysis is not coordinated with other HI-upland OUs.	10. Work with all upland responsible parties to coordinate groundwater monitoring programs between all upland OUs.	PRPs	EPA	9/28/2015	Complete	June 2011

Recommendation 1

The Steering Committee (representatives for the Harbor Island S&G-OU1 Settling Defendants) completed an evaluation of Institutional Controls (ICs) for the S&G-OU1 in January 2010 (TechSolv, 2010; see Appendix C). Information included results of a title search and summary of the current property owners, common name for the properties at the time of the CD, legal description of the property, and conveyances and covenants. Per the requirements of the CD, a certified copy of the CD was filed with King County on August 21, 1996. The entities owning or responsible for environmentally capped properties include: Port of Seattle (POS), Duwamish Properties LLC, The Dutchman LLC, King County, Union Pacific Railroad (UPRR), and Paul and Dianne Defaccio (Harbor Island Machine Works). Annual cap monitoring reports have been submitted to EPA by the POS, other responsible parties still have not been consistently submitting reports.

Recommendation 2

Properties that contain environmental caps are required to have an environmental covenant. The 2010 Evaluation of Institutional Controls (TechSolv, 2010) indicated that covenants had not been filed for all properties owned by the POS, King County, Harbor Island Machine Works, and UPRR. Environmental covenants consistent with the Uniform Environmental Covenants Act (UECA) were filed for the King County and UPRR properties in 2013. Covenants for the remaining properties have not been completed.

Recommendation 3

A Geoprobe Investigation was completed in July 2011 to delineate the limits of the TPH hot spot on the Todd property. Excavation of soil containing TPH concentrations greater than 20,000 mg/kg was completed in October 2011. Soil sampling confirmed that all accessible hot spot soil was removed. A total of 2,400 tons of soil was removed and disposed off-site. Following excavation, an asphalt cap was placed and constructed per the ROD requirements. Testing verified the required minimum permeability of 10^{-5} centimeters/second (cm/s).

Recommendation 4

Historically, both total cyanide and available cyanide were analyzed in groundwater samples. In 2011, EPA approved the discontinuation of total cyanide analyses and approved using the available cyanide method instead for compliance monitoring. Analysis of available cyanide, by method MCAWW 1677, measures both free and weak acid dissociable cyanide. Conservative cleanup goals of 1 μg/L are based on this more toxic free-cyanide form; therefore, use of the available cyanide method is appropriate. The current available cyanide reporting limit is 2 micrograms/liter (μg/L) as the analytical laboratory is unable to achieve a reporting limit at or below the ROD cleanup level of 1 μg/L.

Recommendation 5

A groundwater flow evaluation was completed in April 2010. Depths to groundwater were measured in the vicinity of well HI-17 during three different tidal stages (low, rising, and lower high tides) over a 24-hour period. Groundwater flow directions were relatively consistent for all three tidal stages measured. Elevations decreased radially outward toward the shoreline from the central portion of the island, near HI-17. The Remedial Investigation (RI) identified a groundwater low in the vicinity of well HI-18; however, due to decommissioning of many of the wells at the site, the current well network is not capable of verifying this feature. Groundwater elevations from the 2010 study indicated the low was not clearly discernible. This may reflect that the low is no longer present due to the substantial modifications at the site from capping at T18.

Recommendation 6

The monitoring program has been modified to obtain an optimized monitoring well network. Monitoring wells were added incrementally to the network in May 2009 based on results of conductivity profiling and evaluation of groundwater quality in the area of the groundwater low. These new wells were sampled quarterly for one year. In September 2010, EPA agreed to modify the monitoring program so that one well from each location of the paired shallow and deep wells was retained. In addition, wells HI-17 and HI-18 were to be sampled for two additional years to verify elevated metals concentrations.

Recommendation 7

Additional analytes were analyzed to verify that concentrations are below cleanup levels and that the monitoring program does not need to be permanently modified. Tetrachloroethylene (PCE) was analyzed at well HI-7 from June 2011 through June 2013. Concentrations were all below the ROD cleanup level of 8.8 µg/L, ranging from 0.12 to 1.1 µg/L. Bis(2-ethylhexyl)phthalate was analyzed at well HI-5 from September 2010 through June 2013. Concentrations were all below the National Recommended Water Quality Criteria (NRWQC) criteria of 2.2 µg/L.

Recommendation 8

Starting in June 2011, wells located along the perimeter of the island were sampled on the low/rising tides to measure groundwater quality during the maximum potential influence from the site to surface water. This process ensures that measured groundwater at compliance wells is representative of island groundwater conditions.

Recommendation 9

Upon further consideration by EPA, no additional evaluation will be completed to reconcile the differences between Harbor Island ROD groundwater cleanup levels and Tribal risk based levels because it is inconsistent to evaluate fish consumption rates when looking only at water quality criteria for organisms.

Recommendation 10

To the extent practicable, the Steering Committee has been coordinating with other PRP groups on the island to provide a more complete snapshot of groundwater conditions.

5.1.3. Work Completed at the Site During this Five Year Review Period

The TPH hot spot identified at Todd Shipyards was remediated since the last FYR. This hot spot was located in the unsaturated zone in a limited area of the facility and completes the remaining requirements of the 1993 ROD (Design Set #3). According to the ROD, soil containing greater than 20,000 mg/kg of TPH is required to be removed. In July 2011, a Geoprobe Investigation was completed to delineate the limits of the hot spot. Excavation of the hot spot was completed in October 2011. Soil sampling confirmed that all accessible hot spot soils were removed. A total of 2,400 tons of soil was removed and disposed off-site. Following excavation, an asphalt cap was constructed over soils with concentrations remaining above cleanup levels per the ROD requirements. The cap is subject to annual inspections in accordance with the ROD. A limited amount of contamination was left under building T-212, the Hazardous Materials Storage Building (see Figure 13). A Geoprobe investigation within the building determined the extent at approximately 700 square feet. If the building is removed in the future, the remaining TPH hot spot must either be covered with a new building or remediated in accordance with EPA Decision Documents.

5.2. Tank Farms OU2

5.2.1. Protectiveness Statement from Last Review

The protectiveness statement from the last FYR states:

> *A protectiveness determination for the TF-OU2 is currently deferred until the following actions have been completed:*
>
> - *Complete an evaluation of hydraulic containment near the shoreline at the BP Plant 1 remediation system to determine if contamination is reaching the West Waterway. Modify the system as necessary.*
> - *Evaluate the nature and extent of contamination near the Shell and KM facilities to determine if it is migrating outside the TF-OU2 boundary. Remediate as necessary.*
> - *Evaluate the nature and extent of contamination at the northern boundary of the Shell Main Terminal. Remediate as necessary.*

5.2.2. Status of Recommendations and Follow-up Actions from Last Review

The status of previous recommendations at TF-OU2 is presented in Table 16.

Table 16. TF-OU2 Status of Recommendations from the 2010 FYR

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
2	1. It is uncertain if hydraulic capture at BP Plant 1 remedial system is maintained.	1. Evaluate hydraulic containment and perform investigations or modify the remediation system as necessary.	Tank Farm Facilities/ PRPs	Ecology	9/28/2015	Complete	December 2014
2	2. Elevated contaminant levels remain near the Shell and KM facilities and it is uncertain if contamination is migrating outside the TF-OU2 boundary.	2. Evaluate the extent and potential migration pathway outside of the TFOU2 boundary.	Tank Farm Facilities/ PRPs	Ecology	9/28/2015	Complete	December 2011
2	3. The source of elevated contaminant levels at the northern boundary of the Shell Main Terminal is uncertain.	3. Evaluate the extent and nature of the remaining contamination.	Tank Farm Facilities/ PRPs	Ecology	9/28/2015	Complete	2013

Recommendation 1

Hydraulic containment was evaluated near wells AMW-01 and AMW-02 (see Figure 7); it was determined that system modifications were not necessary. To address the elevated benzene concentrations at wells AMW-01 and AMW-02 at Plant 1, BP evaluated potential remediation system modifications. Installation of deeper extraction wells were proposed for the groundwater/LNAPL extraction system. This proposal was rejected due to the potential risk of increased sheens and discharge of free LNAPL to surface water. Restarting the air sparging system near AMW-01 and AMW-02 was also considered. Historically, the air sparge wells in this area needed to be operated at conservative flows and pressures to prevent the injected air from short-circuiting into the neighboring West Waterway. The conservative flow rates and pressures to these sparge wells likely minimized sparging effectiveness. The potential for operating the sparge wells at increased flow rates and pressures was evaluated. However, short circuiting of sparge air would be magnified under increased flows and pressures, resulting in minimal volatilization of hydrocarbons in this deeper groundwater. Additionally, the creation of preferential pathways could reduce effective capture of the groundwater/LNAPL Recovery System in this area and potentially provide a more direct pathway for surface water and groundwater exchange in this area. For these reasons sparging in the deeper groundwater near wells AMW-01 and AMW-02 was rejected from consideration.

Recommendation 2

Kinder Morgan and Shell have worked together to evaluate the 13th Avenue SW petroleum occurrence. Kinder Morgan installed one monitoring well at the down-gradient property boundary and four temporary wells in 2011. Shell installed two wells on their property in 2012, MW-305 and MW-306. Following an evaluation of the data, Ecology determined that Kinder Morgan and Shell have identified the lateral extent of the TPH-gasoline within the shallow groundwater, documented that this petroleum occurrence is contained, that the concentrations are decreasing, and monitored natural attenuation (MNA) has been occurring. Ecology has agreed that MNA is an appropriate remedy at this location and that it has been successful in reducing petroleum concentrations in groundwater in the immediate area (Ecology 2014b, 2014c; see Appendix C).

Recommendation 3

Several investigations and pilot tests were completed in the area near TX-03A at the northern boundary of the Shell main terminal. Eight wells were installed in 2011 and 2012 to delineate the extent of groundwater contamination. A soil gas assessment was conducted in May 2013 to further delineate the source of petroleum hydrocarbons in the TX-03A area. Twenty soil vapor probes were installed and samples analyzed for TPH and BTEX. Pilot tests for air sparge and SVE were completed in 2013 to evaluate the most effective long-term remedial strategy for treating residual hydrocarbons in this area. Ecology and Shell are reviewing the pilot test results to determine the most effective remediation for this area. See Section 6.5.1 for additional details.

5.2.3. Work Completed at the Site During this Five Year Review Period

A focused feasibility study (FFS) was prepared in 2011 at the Kinder Morgan facility to evaluate remedial alternatives for final on-site restoration. Of the alternatives evaluated, enhanced bioremediation using sulfate application appeared to be the best-available and most cost-effective alternative. Ecology approved the selection of this alternative in a letter dated September 8, 2011. The bioremediation consists of land application of epsom salt and gypsum. These reagents are delivered to the groundwater through precipitation (supplemented with irrigation) and infiltration. Applications began in 2013 and were repeated in 2015.

Several investigations have occurred during the last five years at the Kinder Morgan site. Data are discussed in Section 6.5.1. The investigations are briefly described below:

- Five soil borings (AUS-SB-1 to AUS-SB-5) were installed to estimate lateral and vertical extent of petroleum concentrations within the B and D Yards. The results indicated that residual petroleum hydrocarbons in soil do not exceed soil cleanup levels and have been addressed through completed remedial actions including excavation and post-excavation confirmation monitoring (Ecology 2014b; see Appendix C). Ecology has concluded that soil contamination has been addressed through previous remediation efforts, except for those soils that were inaccessible due to the proximity of tanks or below the water table.
- A monitoring well (MW-26) was installed at the Kinder Morgan down-gradient property boundary in 2011.
- Four temporary monitoring wells, TMW-E1 through TMW-E4, were installed in 2011 to determine whether hydrocarbon impacts present on the Kinder Morgan property were similar to those observed along 13th Avenue SW corridor and to determine whether these impacts appear to be related to a release that occurred in the E Yard in the late 1990s.
- During installation of two anode wells to augment the existing cathodic protection system in Yard E, a black tarry substance was encountered in one of the borings at approximately 5 feet bgs. Samples of the material indicate that it was likely diesel fuel 6, Bunker C, or similar and had undergone substantial biological degradation. There was no further work to determine extent or potential impacts.
- Six wells (TMW-1 to TMW-6) were installed to evaluate the effectiveness of the sulfate land application to sustain elevated sulfate concentrations in shallow groundwater in order to measure the effectiveness of this cleanup treatment system.

In September 2013, Shell was completing an “In-Line” inspection of their dock lines at the Shoreline Manifold area. During the fill operation, a maintenance hose ruptured. Less than three barrels of diesel product were released to the surrounding area. Approximately 2.4 barrels of the diesel were removed from the surface using a vacuum truck and sorbent pads, 8-10 cubic yards of gravel were removed and pressure washed, and pooled diesel product was vacuum-extracted near well MW-212. Confirmation soil samples collected from the excavated area following the release had concentrations below Shoreline soil cleanup levels. Observations of Elliott Bay at the time of the spill indicate that surface water was not impacted from the release. Groundwater samples were also collected from nearby wells and did not indicate an impact to groundwater from the spill.

Several investigations have occurred during the last five years at the Shell site. Data are discussed in Section 6.5.1. Investigations are briefly described below:

- Shell installed two wells on their property in 2012, MW-305 and MW-306, near well SH-04 and the 13th Avenue SW residual contamination.
- In the TX-03 area at the northern boundary of the Shell main terminal, eight new wells have been installed and a soil gas assessment completed to delineate the extent of contamination. Pilot testing for air sparging, SVE, and pumping tests was completed in 2013 to evaluate the most effective long-term strategy for treating residual hydrocarbons. Pilot test wells installed include one air sparge test well, one SVE well, two monitoring wells, and one pumping test well.
- In September 2013, a video survey was conducted to assess if impacted groundwater is entering the stormwater system under SW Florida Street in the area north of the main terminal tank farm. Cracks were discovered in the pipeline and it was hypothesized the groundwater was entering the stormwater system. Groundwater samples were subsequently collected and it was concluded that site contaminants in concentrations above cleanup levels are entering the City of Seattle stormwater system. Shell is currently reviewing options to repair the stormwater system and plans to conduct additional characterization in the area.

5.3. Lockheed Upland OU3

5.3.1. Protectiveness Statement from Last Review

The protectiveness statement from the last FYR states:

> *The remedy at the LU-OU3 is protective of human health and the environment in the short-term because a cap is in place to prevent exposure to contaminated soil and limit leaching of soil contaminants. However, in order for the remedy to be protective in the long term permanent cap repairs must be completed, appropriate restrictive covenants must be recorded, the potential for PCE to impact the waterway must be evaluated, and the long term monitoring program must be modified.*

5.3.2. Status of Recommendations and Follow-up Actions from Last Review

The status of previous recommendations at the LU-OU3 is presented in Table 17.

Table 17. LU-OU3 Status of Recommendations from the 2010 FYR

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
3	1. The cap frequently has ponded water, plant growth, and asphalt cracks.	1. Permanently repair cap problems and construct stormwater controls consistent with plans for POS redevelopment.	POS	EPA	9/28/2011	Complete	2011
3	2. Appropriate restrictive covenants are not in place for all required properties.	2. Negotiate UECA Covenants.	Lockheed	EPA	9/28/2011	Ongoing	
3	3. Groundwater monitoring program needs modification.	3. Assess groundwater flow direction, tidal influence, and appropriate screen intervals and modify groundwater monitoring network as necessary.	Lockheed	EPA	9/28/2011	Complete	October 2011
3	4. Five-Year Review sampling event identified several constituents that may need to be included in the groundwater monitoring analyte list.	4. Include analyses for PCE and bis(2-ethylhexyl)phthalate.	Lockheed	EPA	9/28/2011	Complete	October 2011
3	5. PCE detected above cleanup goals near the waterway.	5. Assess groundwater flow and potential for PCE to impact the waterway.	EPA	EPA	9/28/2015	Complete	June 2014
3	6. ROD groundwater cleanup levels may not be protective of marine sediments.	6. Verify that ROD groundwater cleanup levels are protective of marine sediments.	EPA	EPA	9/28/2015	Complete	NA

<u>Recommendation 1</u>

POS completed the T10 Utility Infrastructure Upgrade Project in 2011. The project included a new stormwater conveyance system, a new continuous pavement cap and security fencing. Based on the site visit conducted for this FYR, ponded water, plant growth, and asphalt cracks are no longer present.

Recommendation 2

UECA environmental covenants have not been completed and this issue will be addressed in this FYR.

Recommendation 3

A tidal study was completed over an 11 day period in October 2011. The study period included a neap tide (small difference between high and low tides) and spring tide (large difference between high and low tides) sequence. Water levels, conductivity, and temperature were continuously recorded at selected wells. The study confirmed the mounding behind the bulkhead during both the spring and neap tides that had also been identified during the 2006 study; however, the neap tide showed a different overall flow pattern than the spring tide with flow toward the southern and northern ends of the bulkhead (see Figures 14 and 15). The tidal study concluded that the monitoring network was appropriate.

Recommendation 4

Starting in October 2011, copper and zinc analyses were included in the monitoring program at selected wells. Bis(2-ethylhexyl)phthalate was analyzed for two consecutive rounds at wells LMW34 and BG-03; concentrations were all below NRAWQC criteria and analysis is no longer required. All shoreline wells continued to be monitored for PCE.

Recommendation 5

PCE continues to be detected at levels above the ROD cleanup level at wells LMW12, LWM26, and LMW27. A porewater sampling event was conducted in June 2014 to determine if PCE is present at the shoreline (point of compliance). PCE was not detected in either of the two samples collected. See Section 6.7.1 for additional details.

Recommendation 6

Upon further consideration by EPA, no additional evaluation will be completed to reconcile the differences between Harbor Island ROD groundwater cleanup levels and Tribal risk based levels because it is inconsistent to evaluate fish consumption rates when looking only at water quality criteria for organisms.

5.3.3. Work Completed at the Site During this Five Year Review Period

The POS redeveloped the Lockheed Uplands property for use as a container cargo marshalling area in 2011. As part of this project, the utility infrastructure was upgraded to protect the LSS OU cap area. Upgrades included a new stormwater conveyance system, a new continuous pavement cap, and security fencing. During construction, a 5,000-gallon UST was discovered in the southwest corner of the site. The UST was full and contained an unknown high viscosity waste oil product. EPA was notified and the tank and its contents were removed from the site. Confirmation soil sampling showed that diesel-range TPH was not found at concentrations above the site specific action level of 10,000 mg/kg. A release of petroleum hydrocarbons likely occurred during tank removal. Subsequently, a soil and groundwater investigation was completed after the tank removal. Diesel-range petroleum hydrocarbons were detected in groundwater at concentrations above MTCA Method A screening levels. Copper was also detected in groundwater above ROD cleanup levels, at concentrations similar to those detected across Harbor Island. No other constituents were detected at concentrations above screening levels. No further action at the tank excavation site was recommended; TPH has been analyzed at shoreline monitoring wells LMW-30 and LMW-31 since October 2012 to verify that contaminants have not migrated toward the West Waterway.

5.4. Lockheed Shipyard Sediment OU7

5.4.1. Protectiveness Statement from Last Review

The protectiveness statement from the last FYR states:

> *For the LSS-OU7, all remedial actions have been completed, and the remedy is currently protective of human health and the environment. However, in order for the remedy to remain protective in the long-term, institutional controls for the sediment cap must be implemented to ensure long-term protectiveness of the remedy. After completion of the ROD for the adjacent LDW Superfund site, and evaluation of long-term monitoring results for this remedy, EPA intends to evaluate this PCB and/or mercury data in light of the results of the LDW risk assessment and the cleanup levels and decisions in the LDW ROD, and in consideration of the consumption rates that have been identified in EPA's 2007 Tribal Framework for assessing risk to Tribes from seafood consumption.*

5.4.2. Status of Recommendations and Follow-up Actions from Last Review

The status of previous recommendations at the LSS-OU7 is presented in Table 18.

Table 18. LSS-OU7 Status of Recommendations from the 2010 FYR

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
7	1. Institutional Controls Study needs to be completed and ICs need to be implemented.	1. Conduct IC Study to evaluate the need for ICs. Implement ICs.	PRP	EPA	October 2011	Complete	April 2012
7	2. ICs necessary for protectiveness of the remedy are not included in a decision document.	2. Include ICs in a decision document.	EPA	EPA	October 2011	Complete	April 2012
7	3. Shoreline wells need evaluation for appropriate screen intervals.	3. Conduct a geoprobe well screen assessment for the shoreline wells.	PRP	EPA	October 2011	Complete	October 2011
7	4. Long Term Sediment Monitoring Data requires further evaluation.	4. EPA intends to evaluate the sediment data in light of the results of the LDW risk assessment and the cleanup levels and decisions in the LDW ROD, and in consideration of the consumption rates that have been identified in EPA's 2007 Tribal Framework for assessing risk to Tribes from seafood consumption.	EPA	EPA	September 2011	Complete – EPA decided not to evaluate the LSS-OU7 sediment in light of the LDW risk assessment because such an evaluation would not affect remedy protectiveness	

Recommendation 1

The PRP submitted an IC study on December 9, 2009. A Restricted Navigation Area (RNA) was established for the LSS-OU7 on April 10, 2012.

Recommendation 2

There have been no decision documents submitted with IC requirements. An RNA was established in 2012 per the OMMP; therefore, a decision document is no longer needed.

Recommendation 3

A tidal study was completed in October 2011 that included salinity monitoring to provide a qualitative assessment of tidal mixing across the site. The vertical salinity distribution in four shoreline wells was also evaluated by measuring salinity at 2-foot intervals from the base of the well screen to the top of the screen interval or water column. EPA approved this methodology in place of conducting a geoprobe well screen assessment. Data indicate that the salinity distribution is highly complex, varying with well location, tidal stage, and depth. Generally, data indicate there is a tidal mixing zone of brackish water that occurs along the shoreline in the southern portion of the site. The degree of tidal mixing in the northern portion of the bulkhead is less and mounding along the bulkhead is greater in this area. The tidal study concluded that the monitoring network was appropriate.

Recommendation 4

Upon further consideration by EPA, no additional evaluation will be completed to reconcile the differences between LSS-OU7 sediment cleanup levels and Tribal risk based levels because the sediment cap is in place and preventing exposure.

5.4.3. Work Completed at the Site During this Five Year Review Period

As part of the T10 Utility Infrastructure Upgrade Project, a stormwater treatment system was constructed which discharges onto the LSS OU cap. An O&M work plan was developed for the stormwater conveyance system as part of the T10 stormwater pollution prevention plan (SWPPP) that includes inspections, storm solids sampling, and annual reporting (Aspect 2012; see Appendix C). Solids sampling in April and December 2013 showed exceedance of Sediment Cleanup Objective (SCO; formerly termed the SQS) criteria for zinc and mercury in the oil water separator. Follow-on actions completed included increased sweeping frequency, clean out of the oil water separating and filter vaults, and coating all galvanized oil water separator components with epoxy. Samples collected from the treatment system in 2014 also contained zinc and mercury above SCO criteria. Additional actions (including collection of additional sediment samples at the discharge point) need to be conducted to mitigate for these exceedances.

5.5. Todd Shipyard Sediment OU9

5.5.1. Protectiveness Statement from Last Review

The protectiveness statement from the last FYR states:

> *For the TSS-OU9, all remedial actions have been completed and the remedy is currently protective of human health and the environment. However, in order for the remedy to remain protective in the long-term, institutional controls for the sediment cap must be*

implemented to ensure long-term protectiveness of the remedy. Also, after completion of the ROD for the adjacent LDW Superfund site, if monitoring data from this OU shows the presence of PCBs and/or mercury, EPA intends to evaluate the sediment data in light of the results of the LDW risk assessment and the cleanup levels and decisions in the LDW ROD, and in consideration of the consumption rates that have been identified in EPA's 2007 Tribal Framework for assessing risk to Tribes from seafood consumption.

5.5.2. Status of Recommendations and Follow-up Actions from Last Review

The status of previous recommendations at the TSS-OU9 is presented in Table 19.

Table 19. TSS-OU9 Status of Recommendations from the 2010 FYR

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
9	1. Institutional Controls Study needs to be completed and ICs need to be implemented.	1. Conduct IC Study to evaluate the need for and implement ICs.	PRP	EPA	October 2011	Not Complete	
9	2. ICs necessary for protectiveness of the remedy are not included in a decision document.	2. Include ICs in a decision document.	EPA	EPA	October 2012	Not Complete	
9	3. Long Term Monitoring data needs further evaluation.	3. EPA intends to evaluate the sediment data in light of the results of the LDW risk assessment and the cleanup levels and decisions in the LDW ROD, and in consideration of the consumption rates that have been identified in EPA's 2007 Tribal Framework for assessing risk to Tribes from seafood consumption.	EPA	EPA	September 2015	Complete – EPA decided not to evaluate the TSS-OU9 sediment in light of the LDW risk assessment because such an evaluation would not affect remedy protectiveness.	

Recommendation 1

An IC study has not been completed and no ICs have been implemented. This is an outstanding issue that is expected to be completed prior to the next FYR.

Recommendation 2

There has been no decision document submitted with IC requirements. This is an outstanding issue that is expected to be completed prior to the next FYR.

Recommendation 3

Upon further consideration by EPA, no additional evaluation will be completed to reconcile the differences between TSS-OU9 sediment cleanup levels and Tribal risk based levels because the sediment cap is in place and preventing exposure.

5.5.3. Work Completed at the Site During this Five Year Review Period

There has been no work completed at the site other than O&M monitoring (discussed under Section IV.F.3).

6. Five-Year Review Process

6.1. Administrative Components

The PRPs for all OUs and affected Tribes were notified of the initiation of the five-year review in July 2014. The Harbor Island Superfund Site Five-Year Review was led by Ravi Sanga of the U.S. EPA, Remedial Project Manager for the Site and Julie Congdon, the Community Involvement Coordinator (CIC). Maura O'Brien (geologist/hydrogeologist) of Ecology assisted in the review of the Tank Farms OU2. Sharon Gelinas (geologist) and Aaron King (environmental engineer) of the U.S. Army Corps of Engineers assisted in the review.

The review, which began on October 2014, consisted of the following components:

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

6.2. Community Notification and Involvement

Activities to involve the community in the five-year review process were initiated with a meeting in September 2014 between the RPM and CIC for the Site. A notice was published in the local newspaper, the West Seattle Herald, on August 15, 2014, stating that there was a five-year review and inviting the public to submit any comments to the U.S. EPA by December 31, 2014. A copy of the notice is available in Appendix G. The results of the review and the report will be made available at the Site information repository located at the EPA Region 10 Records Center, 1200 Sixth Avenue, Seattle, WA 98101.

6.3. Document Review

This five-year review included a review of relevant documents including O&M records and monitoring data. Applicable soil, groundwater, and sediment cleanup standards, as listed in the RODs, were also reviewed. No documents or data were reviewed for the West Waterway Sediments OU-8 and East Waterway Sediments OU-10. Documents can be reviewed at EPA Region 10 Superfund Records Center. Appendix C lists all documents reviewed for this FYR.

6.4. Soil and Groundwater OU1

6.4.1. Data Review

LNAPL extraction at Todd Shipyards is currently active at the west shed recovery wells, FW-17, FW-18, and FW-19. East shed recovery wells were shut down in 2013 due to the lack of LNAPL recovery. Quarterly LNAPL recovery in 2014 ranged from 254 to 955 gallons. LNAPL thickness measurements from the 4th Quarter 2014 show 0.15 to 1.24 feet of LNAPL remaining around the west shed recovery wells (see Figure 4). The 1.24-foot measurement is likely biased high due to problems with oil/water emulsions in the well. Recent data indicates that LNAPL thickness in the west shed wells does not appear to be declining significantly (see Figure 16). As the LNAPL system is systematically shut down, groundwater monitoring as required in the ROD should be implemented to demonstrate that contaminants are not migrating into the marine environment.

Groundwater sampling for the S&G-OU1 is conducted semi-annually according to the modified groundwater monitoring plan (see Figure 5 for well locations). Analyses include total metals (arsenic, cadmium, copper, lead, mercury, nickel, silver, thallium, and zinc), available cyanide, and benzene at well TD-06A. Table B-1 (in Appendix B) presents the minimum and maximum concentrations by well for each constituent analyzed. Exceedances of ROD cleanup goals over the last five years (2010 – 2014) include arsenic, cadmium, copper, lead, mercury, nickel, zinc and cyanide. The highest concentrations were observed at inland well HI-17, consistent with historical data.

Those wells with a detection of a ROD COC concentration above the cleanup goal in the last five years were evaluated for trends using the Mann-Kendall nonparametric test for trend (see Table 20). Only those wells with less than 50% non-detects were evaluated. In general, the data show stable or no significant trends. Monitoring well MW-01 showed a statistically decreasing trend for copper and a probably decreasing trend for lead. Recent data indicate concentrations of these metals are below ROD cleanup levels.

Table 20. Mann-Kendall Trend Analysis (2010-2014), S&G-OU1

Well	Constituent	# Data Points/ # non-detect results	Trend Test Result	Confidence Factor
HI-17	Arsenic	9/0	No Trend	69.4%
HI-17	Cadmium	9/0	Stable	46.0%
HI-12	Copper	9/0	Stable	54.0%
HI-17	Copper	9/0	No Trend	69.4%
HI-7	Copper	9/0	No Trend	69.4%
MW-01	Copper	9/0	Decreasing	99.4%
MW-213	Copper	9/0	No Trend	61.9%
AC-06A	Lead	9/0	No Trend	54.0%
HI-1	Lead	9/0	No Trend	87.0%
HI-12	Lead	9/0	No Trend	46.0%
HI-16	Lead	9/1	No Trend	46.0%
HI-17	Lead	9/0	No Trend	76.2%
HI-18	Lead	9/2	No Trend	61.9%
HI-2	Lead	9/0	No Trend	69.4%
MW-01	Lead	9/0	Probably Decreasing	94.0%
MW-213	Lead	9/0	No Trend	69.4%
MW-213	Mercury	9/0	No Trend	61.9%
HI-17	Nickel	9/0	No Trend	82.1%
HI-12	Zinc	9/0	No Trend	69.4%

As part of the FYR, EPA requested sampling of all monitoring wells and analysis for the full list of COCs identified in the ROD. In addition, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and antimony were analyzed at the point of compliance wells to determine if the remedy is functioning as intended. Table B-2 (in Appendix B) presents the results of this sampling event completed in November 2014. Detected concentrations of constituents without ROD cleanup levels were compared to the lower of the NRWQC for marine acute and chronic exposures and for human consumption of organisms. A brief summary of the comprehensive sampling results from November 2014 follows:

- Cyanide, arsenic, cadmium, copper, lead, nickel, and zinc were detected at concentrations above ROD cleanup goals, consistent with historical semi-annual sampling results.
- Bis(2-ethylhexyl)phthalate was detected slightly above the NRWQC at well MW-01.

Semi-annual and comprehensive FYR sampling results indicate that concentrations of metals above ROD cleanup levels exist in groundwater at S&G-OU1. Exceedances of ROD cleanup levels are typically sporadic or localized occurrences. The lack of data trends in point of compliance and sentinel wells indicate that active migration is currently not occurring. With the exception of bis(2-ethylhexyl)phthalate at MW-01, the comprehensive monitoring did not indicate that the monitoring program analyte lists needs modification. However, it is recommended that bis(2-ethylhexyl)phthalate is analyzed again during the next sampling event to confirm the value.

6.4.2. Site Inspection

The site inspection was conducted on February 2015. In attendance were Ravi Sanga, U.S. EPA; Sharon Gelinas and Aaron King of the U.S. Army Corps of Engineers; and personnel associated with the inspected properties. The purpose of the inspection was to assess the protectiveness of the remedy. The Site Inspection Checklist and a Trip Report with photographs are provided in Appendix E.

The primary inspection areas were at Terminal 18, owned by the POS, and Todd Shipyards. Typical operations and maintenance, as well as activities since the last five-year review, were discussed. Cap inspections occur regularly at the inspected properties, and appropriate maintenance actions are taken as necessary. Although some standing water, plants, and cracks were observed in some areas during the inspection, the caps are generally in good condition and functioning as intended. LNAPL recovery continues at the west shed in the Todd Shipyards, which is part of OU1. The LNAPL recovery and treatment system appears to be well-maintained, and is in good operating condition.

6.4.3. Interviews

During the FYR process, interviews were conducted with PRP representatives involved in Site activities or aware of the Site. The purpose of the interviews was to document any perceived problems or successes with the remedy that has been implemented to date. Brick Spangler (POS, Environmental Program Manager) and Warren Hansen (Windward Environmental, POS Consultant) were interviewed for OU1. Interviewees indicated that the remedy is functioning as expected. There were no concerns with the project. Complete interview reports are included in Appendix D.

6.4.4. Institutional Controls

ICs are required for properties containing environmental caps (see Figure 3 for cap areas). Table 21 summarizes the current state of ICs for the S&G-OU1. Seven property owners are required to have environmental covenants. The POS (Terminal 18 property) signed an Environmentally Critical Area Covenant and Permanent Conditions covenant with the City of Seattle in 2005; however, this covenant does not meet IC objectives as it pertains to construction on steep slopes.

The Dutchman LLC has a restrictive covenant with Ecology signed in 2002. Duwamish Properties LLC has a restrictive covenant with EPA signed in 1999. Todd Shipyards installed a new cap in 2011 and is currently working on a UECA covenant. This covenant for Todd Shipyards is expected to be completed before the next FYR. New covenants following UECA guidelines have been signed with King County and UPRR in 2013. It is recommended that all properties with environmental caps negotiate and complete UECA-compliant covenants to ensure that restrictive covenants are legally valid and enforceable.

Although not specifically required in the ROD, EPA is in the process of implementing UECA-compliant covenants at non-capped areas to ensure that land use at each property remains industrial and that groundwater is only used for CERCLA remedial action processes. Currently, the only property with a non-capped area UECA-compliant covenant is the Bluefield site, a habitat restoration project being planned for a 2.6 acre piece of land located on the east side of the West Waterway, partially beneath the Spokane Street Bridge and West Seattle Bridge. The proposal includes creation of two new off-channel inlets and will begin construction in fall of 2015.

Table 21. Summary of Implemented ICs, S&G-OU1

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soil	Yes	Yes	POS	Require long term maintenance of caps; warn future property owners of remaining contamination; specify procedures for handling and disposal of excavated contaminated soil	None
			Dutchman LLC		Ecology Covenant, 2002
			King County		UECA Covenant, 2013
			Harbor Island Machine Works		None
			Duwamish Properties LLC		EPA Covenant, 1999
			UPRR		UECA Covenant, 2013
			Todd Shipyards		In progress

6.5. Tank Farms OU2

6.5.1. Data Review

Data review for TF-OU2 was based on the Ecology Periodic Review Reports prepared for each of the three Tank Farm facilities (Ecology 2014a, 2014b, 2014c; see Appendix C).

The Tank Farm PRPs periodically collect groundwater elevations during the same time period to obtain a comprehensive flow map for OU2. Figure 17 shows groundwater contours based on data from the 2011 gauging event. Resultant contours are consistent with historical interpretations; a groundwater high exists toward the center of the island with groundwater flow radially outward. At BP Plant 1 property, adjacent to the West Waterway, flow directions can vary seasonally but are generally west towards the waterway, and south to southwest along the southern property boundary.

BP

Performance monitoring at Plant 1 includes groundwater monitoring for TPH-G, TPH-D, TPH-O, benzene, cPAHs, groundwater elevations, and the presence of LNAPL. The groundwater monitoring program at Plant 1 includes 18 wells sampled at varying frequencies (see Figure 18). Groundwater monitoring at Plant 2 consists of one well sampled semi-annually (see Figure 19).

At BP Plant 1, groundwater compliance monitoring wells AMW-01 through AMW-05, located along the waterfront, have had concentrations below cleanup levels for TPH-G, TPH-D, and TPH-O for all quarterly groundwater monitoring events since installation. These wells have also had concentrations below cleanup levels for benzene, with the exception of wells AMW-01 and AMW-02. Benzene concentrations at AMW-01 and AMW-02 have been below cleanup levels since June 2014 and September 2014, respectively. Concentration trends were evaluated using the Mann-Kendall nonparametric test for trend (see Table 22). Concentrations at AMW-01 and AMW-02 have a significantly decreasing trend. Carcinogenic PAHs are analyzed annually at compliance monitoring wells AMW-01 through AMW-05. Cleanup levels for cPAHs were exceeded once at AMW-04 and AMW-05. Concentrations of cPAHs are not typically detected at these wells. When detections occur it has often been associated with laboratory quality control deficiencies that affect the validity of the results.

TPH-G and benzene are also detected at several inland wells at BP Plant 1: GM-14S, GM-15S, GM-24S, MW-2-T9, and MW-3-T9 (see Figure 18 for well locations). Trends were evaluated using the Mann-Kendall test and show that one well, MW-2-T9, has a significantly decreasing trend. All other wells with detections above cleanup levels had stable or no significant trends.

At Plant 2, THP-G concentrations at GM-19S have been below cleanup levels since 2007. Plant 2 well locations are shown on Figure 19. Benzene concentrations at GM-19S were above the cleanup level periodically during the last five years; however, the data show stable trends.

In general, groundwater monitoring data at BP Plants 1 and 2 show that concentrations of TPH-G and benzene are decreasing or stable.

Table 22. Mann-Kendall Trend Analysis (2010-2014), TF-OU2, BP

Well	Constituent	# Data Points/ # non-detect results	Min-Max Concentration (mg/L)	Trend Test Result	Confidence Factor
AMW-01	Benzene	20/0	0.0084 – 0.282	Decreasing	>99.9%
AMW-02	Benzene	20/0	0.0057 – 0.21	Decreasing	>99.9%
GM-15S	Benzene	14/7	<0.001 – 0.4	No Trend	56.4%
MW-2-T9	TPH-G	20/0	0.38 – 2.2	Decreasing	99.8%
MW-3-T9	Benzene	20/0	0.001 – 0.172	No Trend	70.7%
GM-14S	TPH-G	20/0	0.245 – 3.66	No Trend	83.3%
GM-24S	TPH-G	20/0	0.244 – 2.46	Stable	76.0%
GM-19S	Benzene	11/0	0.01 – 0.16	Stable	77.7%

Kinder Morgan

The groundwater compliance monitoring program was modified in 2014 and consists of 44 wells sampled semi-annually (see Figure 8). Ecology approved this modification on August 13, 2014. Performance monitoring of the sulfate bioremediation was conducted quarterly through 2014, at which time it will be reduced to semi-annually.

Residual contamination in the area along 13th Avenue SW and well SH-04 area was jointly investigated by Kinder Morgan and Shell. A monitoring well (MW-26) was installed at the Kinder Morgan down-gradient property boundary in 2011. TPH and BTEX were not detected in soil or groundwater indicating that groundwater contamination does not extend off-site in this area. Four temporary monitoring wells, TMW-E1 through TMW-E4, were installed in 2011 to determine whether hydrocarbon impacts present on the Kinder Morgan property were similar to those observed along 13th Avenue SW corridor and to determine whether these impacts appear to be related to a release that occurred in the E Yard in the late 1990s. Soil sample results were below cleanup levels. Groundwater samples showed detections of TPH-G and benzene above cleanup levels; however, forensic analyses indicated middle boiling point material, similar to a kerosene or heavily degraded jet fuel that is not consistent with the released material from the late 1990s (gasoline).

Concentration trends in wells along 13th Avenue SW (A-27, A-28R, MW-23, and MW-24) were evaluated using the Mann-Kendall nonparametric test for trend (see Table 23). All of the wells show a decreasing or probably decreasing trend with the exception of benzene at well A-27. There was only one sample with benzene above the cleanup level during the last five years, and concentrations are currently below cleanups levels indicating that concentrations may be on a declining trend.

Elevated TPH-G and benzene concentrations remain in the western portion of the B and D Yards. An evaluation of trends generally show decreasing concentrations over the last five years (see Table 23). Kinder Morgan is using sulfate land application to enhance biodegradation of COCs; however, some recent concentrations are still above cleanup levels. Sulfate concentrations in the performance monitoring wells increased following the initial bioremediation applications in 2013. Concentrations of TPH-G and benzene appeared to decrease slightly in several wells, but concentrations have not significantly decreased since the applications (see results for wells TMW-4, TMW-5, TMW-6, and well 12 in Table 23). It is likely too early to determine if the sulfate applications will successfully reduce concentrations below cleanup levels.

Table 23. Mann-Kendall Trend Analysis (2010-2014), TF-OU2, Kinder Morgan

Well	Constituent	# Data Points/ # non-detect results	Min-Max Concentration (mg/L)	Trend Test Result	Confidence Factor
A-27	TPH-G	20/0	1 – 3.4	Probably Decreasing	91.3%
A-27	Benzene	20/0	0.012 – 0.078	Increasing	>99.9%
A-28R	TPH-G	19/0	0.81 – 7.3	Decreasing	97.9%
A-28R	Benzene	19/0	0.015 – 0.65	Decreasing	99.9%
MW-7	TPH-G	20/0	1.3 – 8.8	Probably Decreasing	93.2%
MW-19	TPH-G	20/0	2.1 – 12	Decreasing	>99.9%
MW-19	Benzene	20/0	0.0028 – 0.15	Decreasing	96.3%
MW-23	TPH-G	19/0	0.27 – 6	Decreasing	>99.9%
MW-23	Benzene	19/0	0.0097 – 0.39	Decreasing	>99.9%
MW-24	TPH-G	19/0	3.1 – 37	Probably Decreasing	93.3%
MW-24	Benzene	19/0	0.088 – 3.1	Decreasing	99.7%
TMW-4	TPH-G	6/0	4 – 7.9	Stable	76.5%
TMW-4	Benzene	5/0	0.13 – 0.21	No Trend	59.2%
TMW-5	TPH-G	6/0	1.3 – 4.3	Stable	64.0%
TMW-5	Benzene	5/0	0.0015 – 0.1	No Trend	88.3%
TMW-6	TPH-G	6/0	3.9 – 7.8	Stable	76.5%
TMW-6	Benzene	5/0	0.002 – 0.037	Stable	59.2%
12	TPH-G	5/0	2.6 – 4.7	No Trend	59.2%
12	Benzene	5/0	0.002 – 0.037	No Trend	59.2%

Shell

Compliance groundwater monitoring is completed semi-annually at about 30 wells (see Figure 9). Samples are analyzed for BTEX, TPH and natural attenuation parameters. Additional sampling was conducted in 2011 and 2012 to assess the residual contamination near wells SH-04 at 13th Avenue SW and the TX-03 area located north of the main tank farm.

At the Shoreline Manifold Area, BTEX and PAH concentrations at the two deep compliance monitoring wells (MW-213 and MW-214) have remained below cleanup levels since January 2004. Low levels of TPH-D have been detected at concentrations below cleanup levels and TPH-G has not been detected since 2004. Additional monitoring was completed in 2013 at the shallow groundwater monitoring wells following a small diesel spill. Data indicate that shallow groundwater and nearby surface water were not impacted.

Residual contamination in the area along 13th Avenue SW and well SH-04 area was jointly investigated by Shell and Kinder Morgan. Two new monitoring wells, MW-305 and MW-306 were installed in 2012 on the Shell property. Benzene and TPH-G were detected at concentrations above cleanup levels. A trend evaluation using the Mann-Kendall nonparametric test for trend (see Table 24) indicates that benzene concentrations are decreasing, but TPH-G concentrations remain stable or have no trend. The most recent data reviewed indicate that benzene and TPH-G concentrations at the SH-04 area are contained and are below cleanup levels. Geochemical parameters indicate that biological activity is occurring. Ecology has agreed that MNA is the appropriate remedy in the area and that compliance monitoring should continue (Ecology 2014c; see Appendix C).

Several investigations have been completed in the well TX-03A area at the north end of the Shell main terminal. Eight monitoring wells and 20 soil gas probes were installed in 2012 and 2013. Groundwater monitoring has been conducted quarterly at these new wells and indicates that benzene and TPH-G are present above cleanup levels in the area surrounding well TX-03A (wells MW-301, MW-302, MW-303, MW-304, MW-307, MW-308, and MW-310). The Mann-Kendall nonparametric test for trend was used to evaluate trends in TPH-G and benzene in the area of TX-03A (see Table 24). Data show stable or no significant trends at well TX-03A, down-gradient well MW-202 (located in the North Tank Farm), or any of the newly installed wells near TX-03A. Geochemical data in the area shows elevated dissolved oxygen (DO), oxygen-reduction potential (ORP), and carbon dioxide concentration indicative of biological activity.

A soil gas assessment was conducted in May 2013 to further delineate the source of petroleum hydrocarbons in the TX-03A area. Twenty soil vapor probes were installed and samples analyzed for TPH and BTEX. High concentrations of TPH were found in the vicinity of the remedial excavation of the Main Tank Farm (see Figure 20). High concentrations of BTEX in soil gas appeared to coincide with high groundwater concentrations detected in monitoring well MW-303.

Several pilot tests, including air sparging and SVE, were conducted in 2013-2014 and are currently being evaluated for additional remediation in the TX-03A area. Geochemical data indicate natural attenuation is occurring; however, since concentrations do not indicate decreasing trends, MNA may not be sufficient and active remediation should be considered.

Table 24. Mann-Kendall Trend Analysis (2010-2014), TF-OU2, Shell

Well	Constituent	# Data Points/ # non-detect results	Min-Max Concentration (mg/L)	Trend Test Result	Confidence Factor
SH-04	TPH-G	11/0	0.94 - 8.15	Stable	82.1%
SH-04	Benzene	11/0	0.0016 - 0.7	Decreasing	100%
MW-305	TPH-G	7/0	1.53 - 6.28	Stable	71.9%
MW-305	Benzene	7/0	0.0844 - 1.34	Decreasing	96.5%
MW-306	TPH-G	7/0	3.06 - 18.5	No Trend	88.1%
MW-306	Benzene	7/0	0.0762 – 1.05	Probably Decreasing	90.7%
TX-03A	TPH-G	12/0	3.11 – 8.51	Stable	47.3%
TX-03A	Benzene	12/0	1.18 – 3.44	Stable	50.0%
MW-202	TPH-G	11/0	3.22 – 6.07	No Trend	50.0%
MW-301	TPH-G	7/0	2.29 – 4.02	Stable	71.9%
MW-301	Benzene	7/0	0.16 – 0.659	No Trend	50.0%
MW-302	TPH-G	9/0	2.69 – 5.86	Stable	76.2%
MW-302	Benzene	9/0	0.393 – 0.98	No Trend	69.4%
MW-303	TPH-G	8/0	6.11 – 12.8	Stable	64.0%
MW-303	Benzene	8/0	0.884 – 3.13	Decreasing	98.4%
MW-304	TPH-G	9/0	2.67 – 5.98	Stable	87.0%
MW-304	Benzene	9/0	0.411 – 1.04	No Trend	69.4%
MW-307	TPH-G	6/0	4.39 – 10.9	Stable	86.4%
MW-307	Benzene	6/0	0.437 – 2.15	Stable	64.0%
MW-308	TPH-G	5/0	0.146 – 3.48	Stable	75.8%
MW-308	Benzene	5/0	0.016 – 0.668	Stable	75.8%
MW-310	TPH-G	6/0	4.92 – 8.37	Stable	76.5%
MW-310	Benzene	6/0	0.772 – 1.8	Stable	86.4%

6.5.2. Site Inspection

Inspections at the Tank Farm OU2 properties were completed by Ecology. A summary of the inspections follows:

- BP: A site visit was conducted on December 4, 2014. The buildings, asphalt cover, and ongoing cleanup action operations at the Site continue to eliminate exposure to contaminated soils by ingestion and contact. The asphalt appears in satisfactory condition and no repair, maintenance, or contingency actions have been required. The Site continues operation as a major petroleum distribution and storage facility. A photo log is available in Appendix F.
- Kinder Morgan: A site visit was conducted on November 19, 2014. The buildings, asphalt cover, remedy, and compliance monitoring at the Site continue to eliminate exposure to contaminated soils by ingestion and contact. The asphalt appears in satisfactory condition and no repair, maintenance, or contingency actions have been required. The Site continues operating as a petroleum storage and distribution terminal. A photo log is available in Appendix F.
- Shell: A site visit was conducted on November 4, 2014. The buildings, asphalt cover, and ongoing cleanup action at the Site continue to eliminate exposure to contaminated soils by ingestion and contact. The asphalt appears to be in satisfactory condition and no repair, maintenance, or contingency actions have been required. The Site continues operation as a major petroleum distribution and storage facility. A photo log is available in Appendix F.

6.5.3. Interviews

During the FYR process, interviews were conducted with PRP representatives involved in Site activities or aware of the Site. The purpose of the interviews was to document any perceived problems or successes with the remedy that has been implemented to date. Following is a list of those interviewed:

- BP: Scott Larsen (TechSolve, Project Manager), Matt Roberts (TechSolve, Staff Scientist), and Paul Supple (BP, Environmental Business Manager).
- Kinder Morgan: Robert Truedinger (Kinder Morgan, Remediation Project Manager).
- Shell: Paul Katz (Shell, Terminal Manager), Perry Pineda (Shell, Environmental PM). Brian Pletcher (AECOM, Project Manager).

Interviewees indicated that the remedy is functioning as expected. There were no concerns with the project. Complete interview reports are included in Appendix D.

6.5.4. Institutional Controls

Restrictive covenants for BP, Kinder Morgan and Shell were recorded between the PRP and Ecology as part of each Consent Decree. The following limitations were imposed: industrial zoning, groundwater shall not be used for any purpose inconsistent with the remedial action, existing structures shall not be modified to expose contamination, and site workers will be instructed to take precautionary actions to avoid direct contact with contamination. A summary of the current ICs are presented in Table 25.

Table 25. Summary of Implemented ICs, TF-OU2

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemente d and Date (or planned)
Soil	Yes	Yes	BP Plants 1 & 2; Kinder Morgan; Shell Main Terminal and Tank Farm, North Tank Farm, Shoreline Manifold Area	Remain industrial, groundwater not used for inconsistent purpose, site workers to take precautions to avoid contact with contamination	Ecology Environmenta l Covenant (2000)
Groundwater	Yes	Yes	BP Plants 1 & 2 Kinder Morgan Shell Main Terminal and Tank Farm, North Tank Farm, Shoreline Manifold Area		Ecology Environmenta l Covenant (2000)

6.6. Lockheed Uplands OU3

6.6.1. Data Review

Groundwater sampling is conducted semi-annually at eight wells (see Figure 10 for well locations). Monitoring constituents are determined on a well-by-well basis. Currently, wells are analyzed for a combination of benzene, PCE, copper, lead, and zinc; although not all wells are analyzed for all constituents. Table B-3 (in Appendix B) presents the minimum and maximum concentrations by well for each constituent analyzed. Exceedances of ROD cleanup goals over the last five years (2010 -2014) include PCE, copper, and zinc.

Those wells with a detection of a ROD COC above the cleanup goal in the last five years were evaluated using the Mann-Kendall nonparametric test for trend (see Table 26). PCE, copper, and zinc concentrations at well LMW3 were found to be decreasing or probably decreasing; likely due to the completion of the T10 stormwater infrastructure project which included grading and placement of a new cap to limit water ponding problems on the old asphalt cap.

PCE concentrations at LMW12 and LMW27 were found to be increasing during the last five years. Longer term trends in PCE concentrations (last ten years) were evaluated at the northern wells LMW12, LMW27, and LMW26 where PCE has been found above ROD cleanup levels. Longer term trends calculated using data between 2005 and 2014 (see Table 27) show that PCE concentrations in LMW27 and LMW26 are indeed increasing over time. The data also appear to exhibit seasonal variations with concentrations typically higher during the April wet season sampling event than in the October dry season sampling event (see Figure 21). Average groundwater flow directions determined during the tidal study indicate that flow in the northern portion of OU 3 near these wells is easterly (inland) during the spring tide and northerly (parallel to the shoreline) during the neap tide (Figures 14 and 15). To determine if PCE could be impacting the waterway, a porewater sampling investigation was completed in June 2014. Two samples were collected from the gravelly beach area adjacent to the site (see Figure 22). Due to the cobbley nature of the bank area near LMW26, samples were not able to be collected adjacent to the well. PCE was not detected in either sample collected indicating that PCE is likely not impacting the waterway. The long-term groundwater monitoring program will continue to be used to monitor the presence of PCE in this area.

Table 26. Mann-Kendall Trend Analysis (2010-2014), LU-OU3

Well	Constituent	# Data Points/ # non-detect results	Trend Test Result	Confidence Factor
LMW3	PCE	9/0	Decreasing	99.7%
LMW12	PCE	9/0	Increasing	96.2%
LMW27	PCE	9/0	Increasing	96.2%
LMW26	PCE	9/0	No Trend	69.4%
LMW3	Copper	9/0	Decreasing	100%
LMW18	Copper	9/0	Stable	61.9%
LMW9	Copper	7/0	Stable	80.9%
LMW12	Copper	7/0	No Trend	61.4%
LMW27	Copper	7/0	Stable	88.1%
LMW26	Copper	7/0	Stable	61.4%
LMW3	Zinc	9/0	Probably Decreasing	94.0%
LMW27	Zinc	7/0	Stable	80.9%

Table 27. Mann-Kendall Trend Analysis (2005-2014), LU-OU3

Well	Constituent	# Data Points/ # non-detect results	Trend Test Result	Confidence Factor
LMW12	PCE	20/0	No Trend	53.8%
LMW27	PCE	20/1	Increasing	>99.9%
LMW26	PCE	20/0	Increasing	>99.9%

As part of the FYR, EPA requested sampling of all monitoring wells and analysis for the full list of COCs identified in the ROD. In addition, VOCs, SVOCs, PCBs, pesticides, TPH, and additional metals were analyzed to determine if the remedy is functioning as intended. Table B-4 (in Appendix B) presents the results of this sampling event completed in October 2014. Samples were collected during low tide to ensure that they were representative of fresh groundwater emanating from the island. Detected concentrations of constituents without ROD cleanup levels were compared to the lower of the NRWQC for marine acute and chronic exposures and for human consumption of organisms. A brief summary of the sampling results follows:

- Copper, zinc, and PCE were detected at concentrations above ROD cleanup levels, consistent with historical semi-annual sampling results.
- Arsenic was detected above the NRWQC for consumption of organisms (0.14 µg/L) but below the NRWQC for marine chronic exposures (36 µg/L).
- Nickel was detected above the NRWQC for marine chronic exposures, consistent with historical LSS-OU7 sampling events. Nickel was not identified as a COC in the ROD.
- Several pesticides (aldrin, gamma-chlordane, 4,4'-DDE, 4,4'-DDT) were detected at estimated quantities above NRWQC. This is consistent with historical pesticide results.
- Diesel Range Organics (DRO) and Residual Range Organics (RRO) were detected above MTCA Method A cleanup levels at inland wells LMW9 and LMW12 and shoreline well LMW30. None of these detections were down-gradient of the UST removed during the T10 stormwater upgrade project.

Semi-annual sampling and comprehensive sampling results indicate that concentrations of metals and PCE exist in groundwater at LU-OU3. PCE shows an increasing trend; however, tidal studies and the porewater sampling event indicate that the waterway is not being impacted. Exceedances of ROD cleanup levels for metals are typically sporadic or localized occurrences. Concentration trends show decreasing, stable, or no significant trends indicating that migration from source areas is not currently occurring. Detections of additional constituents during the comprehensive sampling is consistent with historical results and do not indicate identification of new sources of contamination. These detections do not warrant modifications to the sampling program.

6.6.2. Site Inspection

The site inspection was conducted on February 2015. In attendance were Ravi Sanga, U.S. EPA; Sharon Gelinas and Aaron King of the U.S. Army Corps of Engineers; and POS personnel associated with LU-03. The purpose of the inspection was to assess the protectiveness of the remedy. The Site Inspection Checklist and a Trip Report with photographs are provided in Appendix E.

Typical operations and maintenance, as well as activities since the last five-year review, were discussed. Cap inspections occur regularly at OU3 and appropriate maintenance actions are taken as necessary. The new cap area was in good condition with minimal water ponding observed.

6.6.3. Interviews

During the FYR process, interviews were conducted with PRP representatives involved in Site activities or aware of the Site. The purpose of the interviews was to document any perceived problems or successes with the remedy that has been implemented to date. Bill Bath (Lockheed Martin, Project Manager) was interviewed for OU3. Mr. Bath indicated that the remedy is functioning as expected. There were no concerns with the project; however, he stated that Lockheed Martin would like to reduce the groundwater monitoring frequency at LU-OU3. Complete interview reports are included in Appendix D.

6.6.4. Institutional Controls

The 1994 Lockheed Uplands ROD required ICs for the capped areas of the site. A review of Institutional Controls was completed by the PRP in December 2009 (Tetra Tech 2009) and indicated that the Consent Decree was entered. There are no restrictive covenants in place describing the necessary procedures for protection. Until restrictive covenants can be recorded and implemented, sufficient protections are currently in place due to the ongoing monitoring program at the upland cap. ICs are expected to be completed before the next FYR. A summary of the ICs for LU-OU3 is presented in Table 28.

Table 28. Summary of Implemented ICs, LU-OU3

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soil	Yes	Yes	Parcel A (7666702940) Parcel B (7666702950) Parcel C (76667030105)	Require long term maintenance of caps; warn future property owners of remaining contamination; specify procedures for handling and disposal of excavated contaminated soil	To be completed by the next FYR

6.7. Lockheed Shipyard Sediments OU7

6.7.1. Data Review

Groundwater sampling is conducted semi-annually at eleven wells, eight shoreline compliance wells and three background wells. Wells are currently analyzed for metals, cyanide, VOCs, and total petroleum hydrocarbons (TPH). Where LU-OU3 ROD cleanup levels are not available, concentrations at the shoreline compliance wells are compared to the lower of the NRWQC for marine acute and chronic exposures and for human consumption of organisms. Exceedances of screening criteria are presented in Table B-5 (in Appendix B). A brief summary of the results over the last five years follows:

- PCE exceeded screening levels consistently at well LMW26. Detections of PCE in the vicinity are discussed above in the Section 6.6.1, Lockheed Uplands OU-3.
- Dissolved arsenic exceeded NRWQC screening criteria for human consumption (0.14 μg/L) at all shoreline wells. There were no exceedances of the NRWQC for marine chronic exposures (36 μg/L).
- Dissolved copper concentrations exceeded screening criteria at wells LMW26, LMW31, LMW32S, and LMW33. The maximum concentration was 23.8 μg/L at well LMW31, more than eight times the screening level of 2.9 μg/L.
- Dissolved nickel concentrations exceeded screening criteria at well LMW26 (once) and LMW33. The maximum concentration was 68.8 μg/L at well LMW33, more than eight times the screening level of 8.2 μg/L.
- Dissolved zinc concentrations exceeded screening criteria at LMW32S and LMW33. The maximum concentration was 117 μg/L at well LMW33, less than twice the ROD cleanup goal of 76.6 μg/L.
- DRO and RRO were analyzed at wells LMW30 and LMW31, located down-gradient of the UST removed during the T10 stormwater infrastructure upgrade project. DRO was detected slightly above the MTCA method A cleanup level once at well LMW30 and RRO was detected slightly above the MTCA method A once each at wells LMW30 and LMW31. There does not appear to be any consistent pattern or trend in the detections indicating migration of TPH from the UST removal area.

Compliance well data indicate that concentrations of copper, nickel, and zinc exceeding NRWQC are present along the shoreline. A highly simplistic partitioning model was used that assumes groundwater concentrations in the compliance wells are representative of porewater concentrations and instantaneous chemical equilibrium occurs between porewater and sediment. Resultant sediment concentrations are below SCO values indicating that concentrations of metals detected in groundwater are unlikely to recontaminate the sediment cap (see Table 29). This is consistent with previous equilibrium partitioning evaluations completed by Lockheed (Tetra Tech, 2006; see Appendix C).

Table 29. Groundwater to Sediment Partitioning Evaluation, LSS-OU7

Constituent	Maximum Groundwater Concentration (µg/L)	Kd[1] (L/kg)	Sediment Concentration[2] (mg/kg)	SCO (mg/kg)
Copper	23.8	22	0.53	390
Nickel	68.8	65	4.47	NA
Zinc	117	62	7.25	410

Notes:
[1] Kd (partition coefficient) values from the Washington State Department of Ecology CLARC database
[2] Sediment concentration calculation: $Conc_{sed} = Conc_{gw} \times Kd / 1000$
NA – not available
SCO – Sediment Cleanup Objective

Since August 2006, five surface (0-10 cm) sediment samples each have been collected annually (excluding 2011) from the open-channel area and the beach area (Figure 11). Analytical results for metals, PAHs, and PCBs are presented in Tables B-6 through B-9 (in Appendix B). Since September 2010, all analyte concentrations have been below the Sediment Cleanup Objectives (SCOs) except the following in the June 2014 event: mercury at sampling locations SED-2 and SED-3 and total PCBs at SED-3. SCOs were formerly termed SQS (Sediment Quality Standard). These two locations (SED-2 and SED-3) are off of the LSS-OU7 cap, and have concentrations that are similar to past analytical results for the open-channel grab samples. The sample materials collected during these sampling events were fine grained sediments, and a general increase in total fines has been observed over the last five years (Tetra Tech, 2014c; see Appendix C). It is possible that there is a fine top layer of sediment that has deposited on the open-channel surface from sources outside the LSS-OU7, which may be indicative of recontamination from top-down sources.

Hydrographic surveys of the slope area and the open-channel area were last conducted in 2010. In the slope area, the survey indicated that no significant changes to the surface of the cap had occurred since remedy implementation; most areas had undergone little to no change. In the open-channel area, no significant elevation changes had occurred since remedy implementation except in a localized area at the far north end adjacent to the BP pier. The location of the apparent localized scouring indicates it is likely caused by barge and tug activity. This erosion site is within the open-channel area and is not part of the cap; therefore, this erosion does not represent a change in the condition of the remedy. The next hydrographic surveys for these areas are scheduled to be completed in 2015.

Topographic surveys of the beach area and mitigation area were last conducted in 2010. The beach area survey indicates most areas have undergone little to no change since remedy implementation. Localized areas of apparent sediment and debris accretion of up to 4 feet are evident adjacent to the bulkhead at the north end of the site and along the interface of the beach and slope areas; the accretion is likely due to regular tidal and depositional activity. The mitigation area survey indicates that material accretion up 1 foot has occurred since remediation. The next topographic surveys for these areas are scheduled for completion in 2015.

Visual and photographic surveys of the beach area, mitigation area, and riparian area are conducted annually. The most recent survey in 2014 indicated that, in the beach and mitigation areas, there was no visual evidence of erosion that would threaten the integrity of the remedy. Furthermore, the riparian area was in good condition; plants appeared to be well-established and healthy.

6.7.2. Site Inspection

There was no site inspection conducted for LSS-OU7 because it is at the bottom of the river and information is available from sediment cap monitoring reports.

6.7.3. Interviews

During the FYR process, interviews were conducted with PRP representatives involved in Site activities or aware of the Site. The purpose of the interviews was to document any perceived problems or successes with the remedy that has been implemented to date. Bill Bath (Lockheed Martin, Project Manager) was interviewed for OU7. Mr. Bath indicated that the remedy is functioning as expected. There were no concerns with the project; however, he stated that Lockheed Martin would like to reduce the groundwater monitoring frequency at OU7. Complete interview reports are included in Appendix D.

6.7.4. Institutional Controls

ICs were not specified in the 1996 ROD. Section 9 of the EPA-approved OMMP requires the PRP to maintain site access and maintain required ICs including establishing a U.S. Coast Guard (USCG) Restricted Navigation Area (RNA). The RNA was established on April 10, 2012 as documented in the Federal Register Volume 77, Number 69, Document Number 2012-8545. A summary of ICs for LSS-OU7 is presented in Table 30.

Table 30. Summary of Implemented ICs, LSS-OU7

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Sediment	Yes	No	Parcel D (7666702960)	Protect capped areas and mitigation and riparian areas.	RNA established April 10, 2012

6.8. *Todd Shipyard Sediments OU9*

6.8.1. Data Review

The TSS-OU9 Year 4 physical integrity monitoring survey was conducted from October 24 – 27, 2011. The physical integrity monitoring was performed by divers at the under-pier capped areas, the Northeast Shoreline Sediment Cap, and the Western Shoreline Habitat Bench to determine if the integrity of the capped material or habitat mix placed during the remedial action has been maintained, and to document conditions following the remedial action and the baseline (2007), Year 1 (2008) and Year 2 (2009) monitoring surveys. Divers completed visual observations at 20 of the 21 transects shown in Figure 12; transect 12, located in the middle of Pier 4N, was not monitored during the survey due to safety concerns. Detailed diver observations and comments (documented on audio and video recordings) were made at 10-foot increments along each transect.

For the under-pier capped areas, diver observations and video footage indicate that the sand cap material has appeared to remain in place and there was no evidence that complete erosion of the sand cap material had occurred at any of the observation locations, either under the piers or at the building berth. The OMMP early action warning level for the under-pier capped areas is any observation of complete erosion of the sand cap. Since there were no exceedances of this early action warning level, no contingency actions for the under-pier areas are warranted at this time. Silt and shell debris are continuing to accumulate on the surface of the sand cap material, and, in some locations, accumulations are up to 20-cm deep. The general increase in the amount of silt and shell debris on the surface of the under-pier capped areas between the Year 2 and the Year 4 monitoring surveys may make documentation of the presence of the sand cap material difficult during future monitoring events.

Based on diver observations in the Northeast Shoreline Sediment Cap, it was confirmed that the riprap slope and the habitat mix placed on top of the riprap during the remedial action remains in place and no erosion of the riprap was noted. In some of the locations, the habitat mix completely covers the riprap slope. This area is well colonized by substantial marine flora and fauna. The OMMP early action warning level for the Northeast Shoreline Sediment Cap is an observation that erosion of the riprap is occurring. Because there were no exceedances of this early action warning level, no contingency actions for this area are warranted at this time.

For the Western Shoreline Habitat Bench, diver observations and video footage confirmed that the habitat mix remains in place and there are no areas of complete erosion. The area is well colonized by marine life and plants, which will continue to assist with material stability over time. The OMMP early action warning level for the Western Shoreline Habitat Bench is any observation of complete erosion of the habitat mix. No contingency actions are required on the habitat bench because the early action warning level was not exceeded.

6.8.2. Site Inspection

There was no site inspection conducted for OU9 because it is at the bottom of the river and information is available from sediment cap monitoring reports.

6.8.3. Interviews

There were no interviews conducted for OU9.

6.8.4. Institutional Controls

No institutional controls were specified in the ROD, subsequent ESDs, or the CD for the TSS-OU9. Specific institutional controls beyond best management practices and review of permit applications through the USACE have not been implemented nor has an Institutional Controls Study been completed.

7. Technical Assessment

7.1. Soil and Groundwater OU1

7.1.1. Question A. Is the remedy functioning as intended by the decision documents?

Yes. For long-term protectiveness, UECA covenants need to be in place for all capped and uncapped properties.

Remedial Action Performance

The remaining hot spot at Todd Shipyards has been removed since the last FYR, completing the requirements of the 1993 ROD (Design Set #3). A small area of contamination was left in place under building T-212 and a cap was placed over soil containing concentrations above cleanup levels.

Groundwater monitoring is conducted semi-annually. Currently, monitoring wells included in the program are screened across the main island-wide fresher water zone or second low salinity zone where island-related impacts would have the greatest potential to discharge to adjacent surface water. One round of comprehensive groundwater monitoring was completed in November 2014 for the FYR. VOCs, SVOCs, and antimony were analyzed at the point of compliance wells to determine if the remedy is functioning as intended. The semi-annual and comprehensive sampling data indicated that concentrations of metals above ROD cleanup levels exist in groundwater at S&G-OU1. One well, MW-01, has shown decreasing trends for copper and lead.

Otherwise, data show stable or no significant trends over the last five years. The lack of data trends in point of compliance and sentinel wells indicate that active migration is currently not occurring. Bis(2-ethylhexyl)phthalate was detected above the NRWQC at compliance monitoring well MW-01 during the comprehensive FYR sampling. It is recommended that bis(2-ethylhexyl)phthalate is analyzed again during the next sampling event to confirm the value.

System Operations/O&M

The LNAPL recovery system at Todd Shipyards has continued operation and all east shed recovery wells have been shut down due to a lack of LNAPL. Recent LNAPL thickness measurements in the west shed wells do not appear to be showing significant declines; however, oil/water emulsions in the recovery wells frequently bias measurements high. As the LNAPL system is systematically shut down, groundwater monitoring as required in the ROD should be implemented to demonstrate that contaminants are not migrating into the marine environment.

Opportunities for Optimization

The S&G OU Steering Committee has proposed a reduction in analytes and the frequency of groundwater monitoring from semi-annual to annual. This proposal is currently under review by EPA.

Early Indicators of Potential Issues

There are no indicators of potential issues.

Implementation of Institutional Controls and Other Measures

The ROD states that ICs are required for seven properties containing environmental caps to provide long-term maintenance of the caps, warn future property owners of remaining contamination, and specify procedures for handling and disposal of excavated contaminated soil. New covenants that follow UECA guidelines have been signed with King County and UPRR in 2013. Duwamish Properties LLC has a restrictive covenant with EPA signed in 1999 and the Dutchman LLC has a restrictive covenant with Ecology signed in 2002. The other three properties do not have any appropriate restrictive covenants in place.

As part of the ICs, annual cap inspections are required for seven properties. Not all properties have submitted reports, but EPA has reviewed the reports that have been submitted. Of those reviewed, the capped areas are being appropriately maintained. The PRPs need to submit the remaining cap inspection reports for the remaining properties so that EPA can review those reports and ensure that the caps are protective.

7.1.2. Question B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Yes. Cleanup levels and toxicity data used at the time of the remedy selection have changed. However, the changes do not affect the protectiveness of the remedy because there is no exposure and the asphalt cap and groundwater are being monitored.

Changes in Standards and TBCs

ARARs cited in the ROD were reviewed to evaluate changes since the ROD was signed in 1993. In addition, requirements promulgated after the 1993 ROD were also evaluated to determine if there were ARARs or To Be Considered (TBCs) necessary to ensure that the remedy is protective of human health and the environment. A summary of the evaluation of each ARAR is presented in Table 31. The table does not include those that are no longer pertinent. For example, ARARs related to remedial design and construction are not included in the table if they do not continue into long-term operations and maintenance.

Cleanup goals specified in the ROD, along with changes in the standards, are shown on Table 32. Cleanup goals for soil were primarily based on criteria contained in the State of Washington MTCA. The more stringent MTCA Method C for industrial soil, which specifies cleanup goals based on a total risk of 10^{-5} from all carcinogens or a hazard index of 1.0 for all non-carcinogens, was applied to the surface soil (depth less than 0.5 feet) where the potential for human exposure is greater. Goals for subsurface soil (depth greater than 0.5 feet) were primarily based on MTCA Method A, which specifies cleanup goals based on a risk of 10^{-5} for individual carcinogens or a hazard quotient of 1.0 for non-carcinogens. In 2001, MTCA amendments reduced the MTCA Method A soil criteria for TPH-G, cadmium, PAHs, arsenic, benzene, ethylbenzene, toluene, and xylenes (see Table 32). However, the selected remedy limits the exposure to these soils through a low permeability cap and ICs.

Groundwater cleanup goals were based on the protection of marine organisms or human health from consumption of organisms. Since the 1993 ROD, there have been revisions to the national recommended water quality criteria (NRWQC) for marine waters that have decreased groundwater standards for thallium, copper, benzene, carbon tetrachloride, trichloroethane, and PCE. Carbon tetrachloride, trichloroethane, and PCE were not detected during the first year of groundwater monitoring and were subsequently dropped. Detected concentrations of benzene and thallium have been below the current standards of 51 μg/L and 0.47 μg/L, respectively. Therefore, the reduction in NRWQC criteria does not call into question the validity of the remedy.

Table 31. S&G-OU1, ARAR Evaluation

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Clean Air Act; Washington Clean Air Act	Federal – CAA – National Ambient Air Quality Standards (NAAQS) (42 USC 7401); State – General Regulations for Air Pollution Sources (Washington Administrative Code [WAC] 173-400, -460)	Actions that result in major sources of emissions must be designed to meet ambient air quality standards.	None of the revisions to WAC 173-400 affect protectiveness.	LNAPL vacuum-enhancement at Todd Shipyards discharges air, treated by a catalytic oxidizer, to the atmosphere.	WAC 173-400: March 2011, August 2011, November 2012
Puget Sound Air Pollution Control Agency (PSAPCA)	PSAPCA (Regulations I, III)	Actions that could involve releases of contaminants to air will be performed in compliance with substantive requirements of a permit from PSAPCA.	Protectiveness is not affected.	LNAPL vacuum-enhancement system at Todd Shipyards discharges air, treated by a catalytic oxidizer, to the atmosphere.	None
Washington Water Pollution Control Act (WPCA); Washington State Water Quality Standards	State- WPCA – Water Pollution Control (Revised Code of Washington [RCW] 90.48); WPCA-Water Quality Standards for Surface Waters (WAC 173-201A)	Actions must achieve water quality standards for surface waters consistent with public health and protection of fish, shellfish and wildlife.	The amendment corrected several language errors and revised some text and tables that needed more clarity. However, none of the changes affect protectiveness.	Hot spot removal, cap, and LNAPL removal will achieve water quality standards for protection of marine organisms.	May 2011
State Water Code; Water Rights	State – Water Code (RCW 90.03); Water Rights (RCW 90.14)	Specifications for the extraction of groundwater will be met during remedial activities; groundwater remediation will be consistent with beneficial uses of the resources and will not be wasteful.	Protectiveness is not affected.	Groundwater extraction and remediation processes at Todd Shipyards will follow specifications and will be consistent with beneficial uses.	None

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Model Toxics Control Act (MTCA)	State – MTCA (RCW 70.105D; WAC 173-340)	MTCA soil cleanup standards for protection of human health in an industrial setting and for protection of groundwater from contaminants leaching from soil will be met.	Protectiveness is not affected.	Soil remediation is no longer active.	None
Water Well Construction Act (WWCA)	State – WWCA Standards for construction and maintenance of water wells (WAC 173-160)	Standards for construction, testing, and abandonment of water and resource protection wells will be met during remediation and monitoring.	Protectiveness is not affected.	Standards must be met for monitoring wells.	None
Clean Water Act (CWA)	Federal – CWA (33 U.S.C. 1251; 40 CFR Part 131)	Standards for protection of marine organisms and human health from ingestion of marine organisms will be achieved through removal of hot spots from both soil and groundwater, capping, and natural biodegradation of remaining low level organics in the groundwater.	The amendments pertain to water quality standards in Florida for the Everglades and flowing lakes and flowing waters of the state, and withdrawal of certain federal water quality criteria applicable to California, New Jersey, and Puerto Rico. Therefore, protectiveness is not affected.	Removal of the floating petroleum product at Todd Shipyards and cap will achieve CWA standards.	December 2010, March 2012, July 2012, August 2012, April 2013, September 2014

Table 32. S&G-OU1, Comparison of ROD Cleanup Goals to Current Standards

Medium	Contaminant	Cleanup Goal per 1993 ROD		Current Standards	
		Goal	Basis of Goal	Standard	Source of Standard
Soil-Surface	Lead	1,000 mg/kg	MTCA A	1,000 mg/kg	MTCA A
	Arsenic	3.60 to 32.6 mg/kg	1 x 10^{-5} risk	N/A	N/A
	Antimony	180 to 677 mg/kg	1 x 10^{-5} risk	N/A	N/A
	Carcinogenic PAHs	0.1 to 36.5 mg/kg	1 x 10^{-5} risk	N/A	N/A
	PCBs	0.18 to 2.99 mg/kg	1 x 10^{-5} risk	N/A	N/A
Soil-Subsurface	Lead	1,000 mg/kg	MTCA A	1,000 mg/kg	MTCA A
	TPH (diesel)	600 mg/kg	MTCA A	2,000 mg/kg	MTCA A
	TPH (gasoline)	400 mg/kg	WA PCS Matrix	100 mg/kg (no detectable benzene)	MTCA A
				30 mg/kg (benzene present)	MTCA A
	Cadmium	10 mg/kg	MTCA A	2 mg/kg	MTCA A
	Chromium	500 mg/kg	MTCA A	19 mg/kg (Chromium VI)	MTCA A
				2,000 mg/kg (Chromium III)	MTCA A
	Mercury	1.0 mg/kg	MTCA A	2 mg/kg	MTCA A
	PAHs	20 mg/kg	MTCA A	2 mg/kg[a]	MTCA A
	Arsenic	200 mg/kg	MTCA A	20 mg/kg	MTCA A
	Benzene	1.0 mg/kg	WA PCS Matrix	0.03 mg/kg	MTCA A
	Ethylbenzene	200 mg/kg	WA PCS Matrix	6 mg/kg	MTCA A
	Toluene	100 mg/kg	WA PCS Matrix	7 mg/kg	MTCA A
	Xylenes	150 mg/kg	WA PCS Matrix	9 mg/kg	MTCA A
Groundwater	Carbon Tetrachloride	4.4 µg/L	Protect Organisms	1.6 µg/L	CWA §304 HH - Marine Waters
	Benzene	71 µg/L	Protect Organisms	51 µg/L	CWA §304 HH - Marine Waters
	Trichloroethane	42 µg/L	Protect Organisms	16 µg/L (1,1,2-trichloroethane)	CWA §304 HH - Marine Waters
	Tetrachloroethylene	8.8 µg/L	Protect Organisms	3.3 µg/L	CWA §304 HH - Marine Waters
	PCBs	0.03 µg/L	Protect Organisms	0.03 µg/L	CWA §304 AL - Marine/Chronic
	Arsenic	36 µg/L	Protect Organisms	36 µg/L	CWA §304 AL - Marine/Chronic

Medium	Contaminant	Cleanup Goal per 1993 ROD		Current Standards	
		Goal	Basis of Goal	Standard	Source of Standard
	Cadmium	8.0 µg/L	Protect Organisms	8.8 µg/L	CWA §304 AL - Marine/Chronic
	Copper	2.9 µg/L	Protect Organisms	3.1 µg/L	CWA §304 AL - Marine/Chronic
	Lead	5.8 µg/L	Protect Organisms	8.1 µg/L	CWA §304 AL - Marine/Chronic
	Mercury	0.025 µg/L	Protect Organisms	0.025 µg/L	173-201A WAC AL - Marine/Chronic
	Nickel	7.9 µg/L	Protect Organisms	8.2 µg/L	CWA §304 AL- Marine/Chronic
	Silver	1.2 µg/L	Protect Organisms	1.9 µg/L	CWA §304 AL - Marine/Acute[b]
	Thallium	6.3 µg/L	Protect Organisms	0.47 µg/L	CWA §304 HH - Marine Waters
	Zinc	76.6 µg/L	Protect Organisms	81 µg/L	CWA §304 AL - Marine/Chronic
	Cyanide	1.0 µg/L	Protect Organisms	1.0 µg/L	CWA §304 AL - Marine/Chronic

Notes:

Highlight indicates current standard is less than that used in the 1993 ROD

MTCA A - Method A Soil Cleanup Levels for Industrial Properties (MTCA Table 745-1)

1 x 10^{-5} risk - Total 1 x 10^{-5} risk excess cancer risk or Hazard Index equal to 1

WA PCS Matrix - State of Washington Petroleum-Contaminated Soil Matrix Rating Method

Protect Organisms - Protection of marine organisms or human health from consumptions of organisms

CWA §304 HH - Marine Waters - Clean Water Act Section 304 National Recommended Water Quality Criteria, Human Health for Marine Waters (consumption of organisms only)

CWA §304 AL - Marine/Chronic - Clean Water Act Section 304 National Recommended Water Quality Criteria, aquatic life, marine, chronic

173-201A WAC AL- Marine/Chronic - Washington Administrative Code Chapter 173-201A, aquatic life, marine, chronic

CWA §304 AL - Marine/Acute - Clean Water Act Section 304 National Recommended Water Quality Criteria, aquatic life, marine, chronic

[a] The latest MTCA value promulgated in 2007 uses this value as the toxicity equivalent to benzo(a)pyrene

[b] No chronic value available

Changes in Exposure Pathways

The exposure assumptions used to develop the Human Health Risk Assessment remain valid. Assumptions included industrial worker incidental ingestion and dermal contact with contaminated soil. Inhalation was not identified as a significant pathway of exposure. Human health exposure to contaminants in groundwater was not evaluated because there was no current or foreseeable use of groundwater for drinking water. Capping of the site has reduced exposure to the remaining contaminated soils and ICs were required to document the location of remaining soil contamination at each property and procedures for handling and disposal of excavated soil from beneath the capped areas. Land use at the site remains industrial and there are no expected land use changes in the future.

Changes in Toxicity and Other Contaminant Characteristics

EPA's Integrated Risk Information System (IRIS) has a program to update toxicity values used by the Agency in risk assessment when newer scientific information becomes available. Risk-based values were used as the basis for cleanup levels for antimony, arsenic, carcinogenic PAHs, and PCBs in surface soil. In the past five years, based on IRIS information, there have not been any changes to the toxicity values for these COCs. The oral slope factors for arsenic, carcinogenic PAHs, and PCBs have all changed since the ROD, but only carcinogenic PAHs has become more stringent (Table 33). The change was relatively small, and the selected remedy limits the exposure to soils through a low permeability cap and ICs.

Table 33. S&G-OU1, Toxicity Values Changed Since the Previous FYR

Contaminant	Toxicity Value Type	Toxicity Values in 1993 ROD		Current Toxicity Criteria	
		Criteria	Source	Criteria	Source
Antimony	RfD_o	4.0×10^{-4} mg/kg-day	IRIS	4.0×10^{-4} mg/kg-day	IRIS
Arsenic	RfD_o	3.0×10^{-4} mg/kg-day	IRIS	3.0×10^{-4} mg/kg-day	IRIS
	SFO	1.8 $(mg/kg\text{-}day)^{-1}$	IRIS	1.5 $(mg/kg\text{-}day)^{-1}$	IRIS
Carcinogenic PAHs	SFO	5.8 $(mg/kg\text{-}day)^{-1}$	EPA ECAO	7.3 $(mg/kg\text{-}day)^{-1}$	IRIS
PCBs	SFO	7.7 $(mg/kg\text{-}day)^{-1}$	IRIS	0.07 to 2.0 $(mg/kg\text{-}day)^{-1}$	IRIS

Notes

Highlight indicates current toxicity criteria is more stringent than that used in 1993 ROD

RfD_o - Oral reference dose

SFO - Oral slope factor

IRIS - EPA's Integrated Risk Information System

EPA ECAO - EPA Environmental Criteria and Assessment Office

Changes in Risk Assessment Methods

Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Toward Meeting RAOs

The selected remedy limits the exposure to these soils through a low permeability cap and ICs. Additionally, there is no indication that groundwater with contaminant concentrations above cleanup levels are migrating to the shoreline.

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

No other information has come to light that could call into question the protectiveness of the remedy.

7.1.4. Technical Assessment Summary

Portions of the remedy are functioning as intended by the decision documents. The remaining hot spot at Todd Shipyards has been removed since the last FYR. LNAPL removal continues at the west shed recovery wells; the east shed recovery wells have been shut down due to a lack of LNAPL. As the LNAPL system is systematically shut down, groundwater monitoring as required in the ROD should be implemented to demonstrate that contaminants are not migrating into the marine environment. Groundwater monitoring across the S&G-OU1 indicate that metals are present above ROD cleanup levels in groundwater. A lack of spatial or temporal trends in the groundwater data indicate that active migration toward the waterways is currently not occurring.

ICs in the form of restrictive covenants are required for the remedy to be protective in the long-term. ICs (restrictive covenants) are required for the seven properties with environmental caps. Only two of these have UECA-compliant covenants. Annual cap inspections are also required to confirm that the cap integrity has not been compromised; however, not all of the properties consistently submit reports.

Cleanup levels and toxicity data used at the time of the remedy selection have changed. Changes to ARARs and toxicity values do not affect the protectiveness of the remedy because the low permeability cap and ICs prevent exposure to soils with contaminant concentrations above the new standards, and contaminants in groundwater have not been detected at concentrations above the new standards. There were no changes in exposure pathways.

7.2. Tank Farms OU2

7.2.1. Question A. Is the remedy functioning as intended by the decision documents?

Yes, the remedy is performing as intended. Active and passive remediation is occurring at the facilities and contaminant concentrations appear to be decreasing.

Remedial Action Performance

<u>BP</u>

At BP Plant 1, groundwater compliance monitoring wells AMW-01 through AMW-05, located along the waterfront, have had concentrations below cleanup levels for TPH-G, TPH-D, and TPH-O for all quarterly groundwater monitoring events since installation. With the exception of wells AMW-01 and AMW-02, these wells have also been below cleanup levels for benzene. AMW-01 and AMW-02 are currently in compliance; and benzene concentrations have been below cleanup level since June 2014 and September 2012, respectively. Trend evaluations indicate that benzene concentrations at these wells are decreasing and additional system modifications are not needed.

At Plant 2, THP-G concentrations at GM-19S have been below cleanup levels since 2007. Benzene concentrations at GM-19S were above the cleanup level periodically during the last five years; however, the data show stable trends.

<u>Kinder Morgan</u>

Residual contamination in the area along 13th Avenue SW and well SH-04 area was jointly investigated by Kinder Morgan and Shell. A new well installed along the property boundary demonstrates that contamination is contained and does not extend off-site. An evaluation of data trends indicates that concentrations are decreasing over time. Ecology has agreed that MNA is an appropriate remedy at this location and has been successful in reducing petroleum concentrations in groundwater in the immediate area.

Elevated TPH-G and benzene concentrations remain in the western portion of the B and D Yards. Data trends indicate decreasing concentrations over the last five years; however, recent concentrations are still above cleanup levels. Enhanced bioremediation using sulfate application began in this area in 2013. Concentrations of TPH-G and benzene appeared to decrease slightly in several wells, but concentrations have not significantly decreased since the sulfate injections. It is likely too early to determine if the applications will successfully reduce concentrations below cleanup levels. Before the next FYR, EPA and Ecology will reassess whether the enhanced bioremediation using sulfate application has reduced concentrations below cleanup levels.

Shell

Several investigations have been completed in the well TX-03A area at the north end of the Shell main terminal. Eight monitoring wells and 20 soil gas probes were installed in 2012 and 2013. Groundwater monitoring has been conducted quarterly at these new wells and indicates that benzene and TPH-G are present above cleanup levels in the area surrounding well TX-03A. Data show stable or no significant trends. Geochemical data in the area shows elevated dissolved oxygen (DO), oxygen-reduction potential (ORP), and carbon dioxide concentration indicative of biological activity; however, COC concentrations do not indicate decreasing trends. Several pilot tests, including air sparging and SVE, were conducted in 2013-2014 and are currently being evaluated for additional remediation in the TX-03A area. RAOs for the Tank Farms OU2 were to remove all accessible contaminated soil and to achieve groundwater cleanup levels at the shoreline areas and inland property boundaries. Since MNA may not be sufficient in this area, active remediation will be considered before the next FYR to reach cleanup levels.

System Operations/O&M

BP Plant 1

A groundwater/LNAPL recovery system is located along the shoreline and was designed to pump shallow groundwater with drawdown extending to the bottom of the LNAPL smear zone, approximately 4 feet in total. Results of operation show that desired drawdown and hydraulic capture/control are being achieved along the waterfront despite reduction in pumping rates from some wells. An inland Soil Vapor Extraction (SVE) system is located south of Plant 1 to treat remaining source areas. To date, the inland SVE has recovered approximately 7,933 pounds of TPH-G.

Kinder Morgan

The Kinder Morgan facility has implemented sulfate land application as a remediation system to increase biodegradation with applications in 2013 and 2015. Passive free-product recovery using absorbent socks is also performed at select wells.

Shell

There are currently no active recovery systems at Shell. Passive free-product recovery continues in the Shoreline Manifold area on an as needed basis.

Opportunities for Optimization

There were no optimization opportunities identified.

Early Indicators of Potential Issues

There are no indicators of potential issues.

Implementation of Institutional Controls and Other Measures

Restrictive covenants for BP, Kinder Morgan, and Shell were recorded between the PRP and Ecology as part of each Consent Decree in 2000. The following limitations were imposed: industrial zoning, groundwater shall not be used for any purpose inconsistent with the remedial action, existing structures shall not be modified to expose contamination, and site workers will be instructed to take precautionary actions to avoid direct contact with contamination.

7.2.2. Question B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Yes. The cleanup levels used at the time of the remedy selection have changed. However, changes do not affect the protectiveness of the remedy because there is no exposure to groundwater above the revised criteria; groundwater was declared non-potable in the EPA ROD and in the Ecology CAPs.

Changes in Standards and TBCs

ARARs cited in the CAPs were reviewed to evaluate changes since they were completed in 1999 and 2000. A summary of the evaluation of each ARAR is presented in Table 34. The table does not include those that are no longer pertinent. For example, ARARs related to remedial design and construction are not included in the table if they do not continue into long-term operations and maintenance.

Table 35 presents cleanup levels listed in the CAPs along with changes in standards. Soil cleanup levels for the TF-OU2 are similar to those in the EPA cleanup goals for the S&G-OU1 and LU-OU3, which were established unique to Harbor Island. There are no changes in soil cleanup levels that would question the validity of the selected remedy.

Groundwater was declared non-potable in the EPA RODs and in the Ecology CAPs. Groundwater cleanup levels were for "the chronic criteria for protection of aquatic organisms (WAC 173-201A) and Section 304 of the Clean Water Act" and were similar to the EPA cleanup goals for the S&G-OU1 and LU-OU3. Since the CAPs have been completed, NRWQC for benzene, ethylbenzene, toluene, and cPAHs have decreased. Ethylbenzene and toluene concentrations at TF-OU2 are below the revised standards. Remaining elevated concentrations of benzene and cPAHs are in areas of active and passive remediation. Therefore, the reduction in NRWQC criteria does not call into question the validity of the remedy.

Surface water standards are not available for TPH. The CAPs selected groundwater cleanup levels for TPH-G, TPH-D, and TPH-O to be protective of surface water. In 2001, MTCA revisions lowered the MTCA Method A groundwater cleanup levels for TPH-G, TPH-D, and TPH-O. However, these standards may not be applicable to TF-OU2.

Table 34. TF-OU2, ARAR Evaluation

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Washington Clean Air Act	State – General Regulations for Air Pollution Sources (WAC 173-400, -460; WA Clean Air Act (RCW 70.94)	Actions that result in major sources of emissions must be designed to meet ambient air quality standards.	None of the revisions to WAC 173-400 affect protectiveness.	Currently operating soil vapor extraction/air sparging systems emissions to air must meet air quality standards.	WAC 173-400: March 2011, August 2011, November 2012
Washington Water Pollution Control Act (WPCA); Washington State Water Quality Standards for Surface Water; Construction projects in State Waters	State- WPCA – Water Pollution Control (RCW 90.48); WPCA-Water Quality Standards for Surface Waters (WAC 173-201A); Construction projects in state waters (RCW 75.20)	Remedial action will achieve water quality standards for surface waters consistent with public health and protection of fish, shellfish, and wildlife. Remedial action component construction along the shoreline will follow the substantive requirements.	The WAC 173-201A amendment corrected several language errors and revised some text and tables that needed more clarity. However, none of the changes affect protectiveness.	Remedial actions are specific to the cleanup of site groundwater. The groundwater cleanup goals are surface water standards that are protective of aquatic organisms. Much of RCW 75.20 was recodified to RCW 77.55. All remedial construction has been completed. Should additional remedial construction occur along the shoreline and in the adjacent waters RCW 75.20 would be applicable.	May 2011
Washington State Water Resources Act (WRA)	State- WRA – Water Resources Act (RCW 90.54)	Selected remediation methods should promote proper utilization of water resources, public health, economic well-being, and preservation of water's natural resources and aesthetic values.	Protectiveness is not affected.	Remedial actions to clean up site groundwater indirectly achieves surface water goals presented in this ARAR.	None
Washington Shoreline Management	State – Shoreline Management Act of 1971 (RCW 70.95)	The remedial actions will ensure that nearby water resources are protected and wisely managed.	Protectiveness is not affected.	One remediation system is located on the shoreline bulkhead, and will ensure that nearby water resources are protected.	None

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Washington Model Toxics Control Act (MTCA)	State – MTCA (WAC 173-340)	MTCA cleanup regulations provide that cleanup actions must comply with cleanup levels for selected hazardous substances, points of compliance, and ARARs.	Protectiveness is not affected.	Currently operating soil vapor extraction/air sparging systems must meet cleanup levels especially for total petroleum hydrocarbons.	None
Washington Solid Waste Management (SWM)	State – SWM (WAC 173-304) (RCW 70.95)	The remedial actions will follow a comprehensive program for solid waste handling, and solid waste recovery and/or recycling that will prevent land, air, and water pollution.	Protectiveness is not affected.	Solid wastes are potentially generated as part of the remedial actions.	None
Washington Hazardous Waste Management (HWM)	State – HWM (RCW 70.105); Dangerous Waste Regulations (WAC 173-303)	The remedial action will provide for the control and management of hazardous waste that will prevent land, air, and water pollution.	None of the revisions to WAC 173-303 affect protectiveness.	Hazardous wastes are potentially generated as part of the remedial actions.	December 2014

Table 35. TF-OU2, Comparison of Cleanup Goals to Current Standards

Medium	Contaminant	Cleanup Goal per CAP		Current Standards	
		Goal	Basis of Goal	Standard	Source of Standard
Soil-Surface	Lead	1,000 mg/kg	MTCA A	1,000 mg/kg	MTCA A
	Arsenic	32.6 mg/kg	1 x 10^{-5} risk	N/A	N/A
Soil-Subsurface	Total TPH (Primary Areas of Concern)	10,000 mg/kg	Protection of Surface Water at Boundary	10,000 mg/kg	Protection of Surface Water at Boundary
	Total TPH (Secondary Areas of Concern)	20,000 mg/kg	Protection of Surface Water at Boundary	20,000 mg/kg	Protection of Surface Water at Boundary
Groundwater	Benzene	71 µg/L	Protect Organisms	51 µg/L	CWA §304 HH - Marine Waters
	Ethylbenzene	29,000 µg/L	Protect Organisms	2,100 µg/L	CWA §304 HH - Marine Waters
	Toluene	200,000 µg/L	Protect Organisms	15,000 µg/L	CWA §304 HH - Marine Waters
	Carcinogenic PAHs	0.031 µg/L	Protect Organisms	0.018 µg/L	CWA §304 HH - Marine Waters
	Copper	2.9 µg/L	Protect Organisms	3.1 µg/L	CWA §304 AL - Marine/Chronic
	Lead	5.8 µg/L	Protect Organisms	8.1 µg/L	CWA §304 AL - Marine/Chronic
	TPH (gas)	1,000 µg/L	Protect Groundwater	1,000 µg/L (no detectable benzene)	MTCA A
				800 µg/L (benzene present)	MTCA A
	TPH (diesel)	10,000 µg/L	Protect Groundwater	500 µg/L	MTCA A
	TPH (oil)	10,000 µg/L	Protect Groundwater	500 µg/L	MTCA A

Notes

Highlight indicates current standard is less than that used in the CAP

MTCA A - Method A Soil Cleanup Levels for Industrial Properties (MTCA Table 745-)

1 x 10^{-5} risk - Total 1 x 10^{-5} risk excess cancer risk or Hazard Index equal to 1

WA PCS Matrix - State of Washington Petroleum-Contaminated Soil Matrix Rating Method

Protect Organisms - Protection of marine organisms or human health from consumptions of organisms

CWA §304 HH - Marine Waters - Clean Water Act Section 304 National Recommended Water Quality Criteria, Human Health for Marine Waters (consumption of organisms only)

CWA §304 AL - Marine/Chronic - Clean Water Act Section 304 National Recommended Water Quality Criteria, aquatic life, marine, chronic

[a] The latest MTCA value promulgated in 2007 uses this value as the toxicity equivalent to benzo(a)pyrene

Changes in Exposure Pathways

Exposure assumptions used in the CAPs remain valid. Assumptions included industrial zoning of the site and the determination that there is no planned future use of the groundwater for drinking purposes.

Changes in Toxicity and Other Contaminant Characteristics

EPA's IRIS has a program to update toxicity values used by the Agency in risk assessment when newer scientific information becomes available. Risk-based values were used as the basis for cleanup levels for arsenic in surface soil. In the past five years, based on IRIS information, there have not been any changes to the toxicity values for arsenic. The oral slope factor for arsenic has decreased since the Cleanup Action Plan, becoming less stringent (Table 36).

Table 36. TF-OU2, Toxicity Values Changed Since the Previous FYR

Contaminant	Toxicity Value Type	Toxicity Values in 1993 ROD		Current Toxicity Criteria	
		Criteria	Source	Criteria	Source
Arsenic	RfD_o	3.0×10^{-4} mg/kg-day	IRIS	3.0×10^{-4} mg/kg-day	IRIS
	SFO	1.8 $(mg/kg\text{-}day)^{-1}$	IRIS	1.5 $(mg/kg\text{-}day)^{-1}$	IRIS

Notes

Highlight indicates current toxicity criteria is more stringent than that used in 1993 ROD

RfD_o - Oral reference dose

SFO - Oral slope factor

IRIS - EPA's Integrated Risk Information System

EPA ECAO - EPA Environmental Criteria and Assessment Office

Changes in Risk Assessment Methods

Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Toward Meeting RAOs

Groundwater COC concentrations in the BP area are generally below cleanup levels or showing stable or decreasing trends. It was shown that groundwater contamination in the KM area is not extending off-site; however, COC concentrations above the cleanup level are present in areas of active and passive remediation. Contaminants in one well in the Shell area are above cleanup levels; several pilot studies have been conducted and active remediation potential is being evaluated.

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

No other information has come to light that could call into question the protectiveness of the remedy.

7.2.4. Technical Assessment Summary

The remedy is performing as intended by the decision documents. Active remediation continues at the BP Plant 1 facility. A groundwater/LNAPL recovery system is located along the shoreline and an SVE system is located inland. Concentrations of COCs along the shoreline are currently below cleanup levels including the two wells with historical exceedances, AMW-01 and AMW-02. Data trends at these wells also indicate that concentrations are decreasing. The Kinder Morgan facility implemented sulfate land application as a remediation system in Yards B and D in 2013. The Kinder Morgan and Shell facilities use passive free-product recovery at select wells on an as needed basis. Residual contamination in the area along 13th Avenue SW and well SH-04 area was jointly investigated by Kinder Morgan and Shell. An evaluation of data trends indicates petroleum contamination is contained and that concentrations are decreasing over time. Ecology has agreed that MNA is an appropriate remedy at this location and has said that it has been successful in reducing petroleum concentrations in groundwater in the immediate area. Several investigations have been completed in the well TX-03A area at the north end of the Shell main terminal. Geochemical data in the area shows elevated dissolved oxygen (DO), oxygen-reduction potential (ORP), and carbon dioxide concentration indicative of biological activity; however, COC concentrations do not indicate decreasing trends. Several pilot tests, including air sparging and SVE, were conducted in 2013-2014 and are currently being evaluated for additional remediation in the TX-03A area. Restrictive covenants for BP, Kinder Morgan, and Shell were recorded between the PRP and Ecology as part of each Consent Decree in 2000.

The cleanup levels used at the time of the remedy selection have changed. Changes to ARARs and toxicity do not affect the protectiveness of the remedy because ICs prevent exposure to soils with contaminant concentrations above the new standards, and contaminants in groundwater detected above the new standards are located in remediation areas. There were no changes in exposure pathways.

7.3. Lockheed Uplands OU3

7.3.1. Question A. Is the remedy functioning as intended by the decision documents?

Yes. Before the next FYR, ICs in the form of restrictive covenants are expected be in place in order to ensure long-term protectiveness.

Remedial Action Performance

Groundwater monitoring is conducted semi-annually. Exceedances of ROD cleanup levels exist at the site for metals and PCE; metals detections are typically sporadic or localized occurrences. PCE, copper, and zinc concentrations at well LMW3 were found to be decreasing or probably decreasing; likely due to the completion of the T10 stormwater infrastructure project which removed water ponding problems on the asphalt cap. PCE concentrations above cleanup levels were found at wells LMW12, LMW27, and LMW26 in the northern portion of the site. PCE concentrations at wells LMW12 and LMW27 were found to be increasing over the last five years. A tidal study completed in 2011 shows average groundwater flow directions toward the east (inland) during the spring tide and northerly (parallel to the shoreline) during the neap tide. To determine if PCE could be impacting the waterway, a porewater sampling investigation was completed in June 2014. Two samples were collected from the gravelly beach area adjacent to the site. PCE was not detected in either sample collected indicating waterway is not being impacted. Monitoring will continue to asses PCE trends. If PCE trends are increasing, EPA will work with the PRPs for additional investigation.

One round of comprehensive groundwater monitoring was completed in October 2014 for the FYR. VOCs, SVOCs, PCBs, Pesticides, TPH, and additional metals were analyzed to determine if the remedy is functioning as intended. Detections of additional constituents above NRWQC during the comprehensive sampling is consistent with historical results and do not indicate identification of new sources of contamination. These detections do not warrant modifications to the sampling program.

System Operations/O&M

The POS redeveloped the Lockheed Uplands property for use as a container cargo marshalling area in 2011. As part of this project, the utility infrastructure was upgraded to protect the LSS OU cap area and eliminate ponding on the upland cap. Upgrades included a new stormwater conveyance system, a new continuous pavement cap, and security fencing. A UST found during construction was removed and samples indicated that a release likely occurred during removal. Down-gradient monitoring wells have not shown any indication of migration toward the waterway.

Opportunities for Optimization

Lockheed has proposed a reduction in the frequency of groundwater monitoring from semi-annual to annual. This proposal is currently under review by EPA.

Early Indicators of Potential Issues

There are no indicators of potential issues.

Implementation of Institutional Controls and Other Measures

The 1994 Lockheed Uplands ROD required ICs for the capped areas of the site. A review of the ICs indicated that the Consent Decree was filed; however, there were no restrictive covenants in place describing the necessary procedures for protection. Annual cap inspections are completed consistently. Maintenance items are completed as necessary to maintain cap integrity. There have been no reported ponding issues in Cap Area 2 since the completion of the T10 infrastructure project in 2011.

7.3.2. Question B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Yes. The cleanup levels and toxicity data used at the time of the remedy selection have changed. However, changes do not affect the protectiveness of the remedy because there is no exposure.

Changes in Standards and TBCs

ARARs cited in the ROD were reviewed to evaluate changes since the ROD was signed in 1994. In addition, requirements promulgated after the 1994 ROD were also evaluated to determine if there were ARARs or TBCs necessary to ensure that the remedy is protective of human health and the environment. A summary of the evaluation of each ARAR is presented in Table 37. The table does not include those that are no longer pertinent. For example, ARARs related to remedial design and construction are not included in the table if they do not continue into long-term operations and maintenance.

Cleanup goals specified in the ROD along with changes in the standards are shown on Table 38. Cleanup goals for soil are similar to the S&G-OU1: MTCA Method C for industrial soil was applied to the surface soil (depth less than 0.5 foot) and MTCA Method A for subsurface soil (depth greater than 0.5 foot). In 2001, MTCA amendments reduced the MTCA Method A soil criteria for cPAHs, arsenic, benzene, ethylbenzene, toluene, and xylenes (see Table 38). However, the selected remedy limits the exposure to these soils through a low permeability cap and institutional controls.

Groundwater cleanup goals were based on the protection of marine organisms or human health from consumption of organisms. Since the 1994 ROD, there have been revisions to the NRWQC for marine waters that have decreased groundwater standards for benzene and PCE. Detected concentrations of benzene have been below the revised standard of 51 μg/L; therefore, this revision does not call into question the validity of the remedy. From October 2010 to October 2014, PCE has been detected above the revised standard of 3.3 μg/L at wells LMW3, LMW7, LMW12, LMW26, and LMW27. Most of these wells also had detections that slightly exceed the ROD cleanup goal of 8.8 μg/L. Therefore, using the lower, revised PCE standard does not affect the protectiveness of the remedy at this time.

Human Health exposure to contaminants in groundwater was not evaluated because there was no current or foreseeable use of groundwater for drinking water. Groundwater cleanup levels in the ROD have been based on the protection of marine organisms and human ingestion of marine organisms.

Table 37. LU-OU3, ARAR Evaluation

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Washington Water Pollution Control Act (WPCA); Washington State Water Quality Standards for Surface Water	State – WPCA – Water Pollution Control (RCW 90.48); WPCA Water Quality Standards for Surface Waters (WAC 173-201A)	These require that surface water quality standards for protection of marine organisms will be achieved at the point of compliance, which is at the shoreline.	The amendment corrected several language errors and revised some text and tables that needed more clarity. However, none of the changes affect protectiveness.	Groundwater is being monitored to assess the effectiveness of the remediation to meet water quality cleanup goals.	May 2011
Model Toxics Control Act (MTCA)	State – MTCA (RCW 70.105D; WAC 173-340)	MTCA identifies cleanup standards for surface water and the point of compliance for these standards. MTCA also specifies numerical cleanup goals for soil and risk based calculation methods for determining cleanup goals in soil.	Protectiveness is not affected.	Groundwater is being monitored to assess the effectiveness of the remediation to meet water quality cleanup goals.	None
Clean Water Act (CWA)	Federal – CWA (33 U.S.C. 1251; 40 CFR Part 131)	These identify federal marine and fresh surface water standards for protection of marine organisms and human health from ingestion of marine organisms. Only the marine water standards apply.	The amendments pertain to water quality standards in Florida for the Everglades and flowing lakes and flowing waters of the state, and withdrawal of certain federal water quality criteria applicable to California, New Jersey, and Puerto Rico. Therefore, protectiveness is not affected.	Groundwater is being monitored to assess the effectiveness of the remediation to meet water quality cleanup goals.	December 2010, March 2012, July 2012, August 2012, April 2013, September 2014
Water Well Construction Act (WWCA)	State – WWCA – Standards for construction and maintenance of water wells (WAC 173-160)	Standards for construction, testing, and abandonment of water and resource protection wells will be met during remediation and monitoring.	Protectiveness is not affected.	Standards must be met for monitoring wells.	None

Table 38. LU-OU3, Comparison of ROD Cleanup Goals to Current Standards

Medium	Contaminant	Cleanup Goal per 1993 ROD		Current Standards	
		Goal	Basis of Goal	Standard	Source of Standard
Soil-Surface	Lead	1,000 mg/kg	MTCA A	1,000 mg/kg	MTCA A
	Arsenic	3.60 to 32.6 mg/kg	1×10^{-5} risk	N/A	N/A
	Carcinogenic PAHs	0.1 to 36.5 mg/kg	1×10^{-5} risk	N/A	N/A
Soil-Subsurface	Lead	1,000 mg/kg	MTCA A	1,000 mg/kg	MTCA A
	TPH (diesel)	600 mg/kg	WA PCS Matrix	2,000 mg/kg	MTCA A
	PAHs	20 mg/kg	MTCA A	2 mg/kg[a]	MTCA A
	Arsenic	200 mg/kg	MTCA A	20 mg/kg	MTCA A
	Benzene	1.0 mg/kg	WA PCS Matrix	0.03 mg/kg	MTCA A
	Ethylbenzene	200 mg/kg	WA PCS Matrix	6 mg/kg	MTCA A
	Toluene	100 mg/kg	WA PCS Matrix	7 mg/kg	MTCA A
	Xylenes	150 mg/kg	WA PCS Matrix	9 mg/kg	MTCA A
Groundwater	Benzene	71 µg/L	Protect Organisms	51 µg/L	CWA §304 HH - Marine Waters
	Tetrachloroethylene	8.8 µg/L	Protect Organisms	3.3 µg/L	CWA §304 HH - Marine Waters
	Copper	2.9 µg/L	Protect Organisms	3.1 µg/L	CWA §304 AL - Marine/Chronic
	Lead	5.8 µg/L	Protect Organisms	8.1 µg/L	CWA §304 AL - Marine/Chronic
	Zinc	76.6 µg/L	Protect Organisms	81 µg/L	CWA §304 AL - Marine/Chronic

Notes

Highlight indicates current standard is less than that used in the 1993 ROD

MTCA A - Method A Soil Cleanup Levels for Industrial Properties (MTCA Table 745-)

1×10^{-5} risk - Total 1×10^{-5} risk excess cancer risk or Hazard Index equal to 1

WA PCS Matrix - State of Washington Petroleum-Contaminated Soil Matrix Rating Method

Protect Organisms - Protection of marine organisms or human health from consumptions of organisms

CWA §304 HH - Marine Waters - Clean Water Act Section 304 National Recommended Water Quality Criteria, Human Health for Marine Waters (consumption of organisms only)

CWA §304 AL- Marine/Chronic - Clean Water Act Section 304 National Recommended Water Quality Criteria, aquatic life, marine, chronic

[a]The latest MTCA value promulgated in 2007 uses this value as the toxicity equivalent to benzo(a)pyrene

Changes in Exposure Pathways

The exposure assumptions used to develop the Human Health Risk Assessment remain valid. Assumptions included industrial worker incidental ingestion and dermal contact with contaminated soil. Inhalation was not identified as a significant pathway of exposure. Human Health exposure to contaminants in groundwater was not evaluated because there was no current or foreseeable use of groundwater for drinking water. Capping of the site has reduced the exposure to the remaining contaminated soils and ICs were required to document the location of remaining soil contamination and procedures for handling and disposal of excavated soil from beneath the capped areas. Land use at the site remains industrial and there are no expected land use changes in the future.

The potential for groundwater containing VOCs to act as a source of contamination to soil gas that may impact indoor air was not fully evaluated at the time the original risk evaluation was prepared. Low concentrations of VOCs have been detected in groundwater at the northern portion of the site near the gas station. For a commercial exposure scenario, a groundwater PCE concentration of 65 µg/L corresponds to a vapor intrusion target risk for carcinogens of 10^{-6} (based on EPA's Vapor Intrusion Screening Level [VISL] Calculator version 3.3.1) The highest detected PCE concentration from 2010 to 2014 in any LU-OU3 well was 30 µg/L. Therefore, vapor intrusion risk for the current commercial scenario is below 10^{-6}.

Changes in Toxicity and Other Contaminant Characteristics

EPA's Integrated Risk Information System (IRIS) has a program to update toxicity values used by the Agency in risk assessment when newer scientific information becomes available. Risk-based values were used as the basis for cleanup levels for arsenic and carcinogenic PAHs in surface soil. In the past five years, there have not been any changes to the toxicity values for these COCs. The oral slope factors for arsenic and carcinogenic PAHs have changed since the ROD, but only carcinogenic PAHs has become more stringent (Table 39). The change was relatively small, and the selected remedy limits the exposure to soils through a low permeability cap.

Table 39. LU-OU3, Toxicity Values Changed Since the Previous FYR

Contaminant	Toxicity Value Type	Toxicity Values in 1993 ROD		Current Toxicity Values	
		Criteria	Source	Criteria	Source
Arsenic	SFO	1.8 $(mg/kg\text{-}day)^{-1}$	IRIS	1.5 $(mg/kg\text{-}day)^{-1}$	IRIS
Carcinogenic PAHs	SFO	5.8 $(mg/kg\text{-}day)^{-1}$	EPA ECAO	7.3 $(mg/kg\text{-}day)^{-1}$	IRIS

Notes

Highlight indicates current toxicity criteria is more stringent than that used in 1993 ROD

SFO - Oral slope factor

IRIS - EPA's Integrated Risk Information System

EPA ECAO - EPA Environmental Criteria and Assessment Office

Changes in Risk Assessment Methods

Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs

The selected remedy limits the exposure to these soils through a low permeability cap. Additionally, there is no indication that groundwater with contaminant concentrations above cleanup levels are discharging at the shoreline.

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

No other information has come to light that could call into question the protectiveness of the remedy.

7.3.4. Technical Assessment Summary

The remedy is functioning as intended by the decision documents. The POS redeveloped the Lockheed Uplands property for use as a container cargo marshalling area in 2011. As part of this project, the utility infrastructure was upgraded to protect the LSS OU cap area and eliminate ponding on the upland cap. Groundwater monitoring shows exceedances of ROD cleanup levels exist at the site for metals and PCE; metals detections are typically sporadic or localized occurrences. PCE concentrations above cleanup levels remain in the northern portion of the site and appear to have an increasing trend. Additional studies conducted since the last FYR (tidal study and porewater sampling) indicate that the waterway is not being impacted.

ICs in the form of restrictive covenants are required for the remedy to be protective in the long-term. ICs (restrictive covenants) are required for the capped areas of the site. There is currently no covenant for the property. Annual cap inspections are submitted consistently and show that the cap integrity has been maintained.

The cleanup levels and toxicity data used at the time of the remedy selection have changed. Changes to ARARs, exposure pathways, and toxicity data do not affect the protectiveness of the remedy.

7.4. Lockheed Shipyard Sediments OU7

7.4.1. Question A. Is the remedy functioning as intended by the decision documents?

Yes. The sediment cap is in place. Upland sources do not appear to be a source to cap recontamination. However, there may be off-site sources that are depositing a fine layer of contaminated sediment in the open-channel area. Annual sediment monitoring will continue to ensure long-term protectiveness.

Remedial Action Performance

Groundwater monitoring is conducted semi-annually at eleven wells. Compliance well data indicate that concentrations of copper, nickel, and zinc exceeding NRWQC are present along the shoreline. An evaluation of equilibrium partitioning indicates that the cap will not be recontaminated due to the observed levels of contamination in groundwater.

System Operations/O&M

As part of the T10 Utility Infrastructure Upgrade Project, a stormwater treatment system was constructed which discharges onto the LSS-OU7 cap. Zinc and mercury have been detected at concentrations above SCO criteria in solids sampled from the treatment system. The POS has implemented BMPs to help mitigate the problem, such as increased sweeping frequency and cleanup out of the treatment system; however, additional actions (which should include collection of additional sediment samples at the discharge point) are required to ensure that contaminated sediment is not being deposited on the cap near the discharge point.

Opportunities for Optimization

Lockheed has proposed a reduction in sampling frequency for the LSS-OU7 groundwater monitoring program from semi-annual to annual, consistent with the SCR/SAP. EPA is currently reviewing this proposal.

Early Indicators of Potential Issues

Fine-grained sediments collected during the most recent sampling event in the open-channel area have mercury and total PCB concentrations greater than their respective SCOs. A general increase in total fines has been observed over the last five years. It is possible that there is a fine top layer of sediment that has deposited on the open-channel surface from sources outside the LSS-OU7, which may be indicative of recontamination from top-down sources. This is expected to be evaluated during subsequent annual sampling events.

Implementation of Institutional Controls and Other Measures

ICs were not specified in the 1996 ROD, but the OMMP requires the PRP to maintain site access and required ICs including establishing a USCG RNA. The RNA was established on April 10, 2012 as documented in the Federal Register.

7.4.2. Question B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Yes. The exposure assumptions and toxicity data used at the time of the remedy selection have changed. However, no change to remedy protectiveness is expected because the sediment cap is in place and preventing exposure.

Changes in Standards and TBCs

The remedial action required for the LSS-OU7 was based on the presence of unacceptable risks to benthic organisms. Cleanup levels for the protection of benthic organisms were derived from Ecology regulations for sediment cleanups. A summary of the ARARs evaluation for LSS-OU7 is provided in Table 40. The table does not include those that are no longer pertinent. For example, ARARs related to remedial design and construction are not included in the table if they do not continue into long-term operations and maintenance.

Table 40. LSS-OU7, ARAR Evaluation

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Water Quality Standards	Federal – Water Quality Standards (33 USC 1251; 40 CFR 131);	Federal criteria for the protection of marine aquatic life are relevant and appropriate for discharges to surface water during sediment remediation.	The amendments pertain to water quality standards in Florida for the Everglades and flowing lakes and flowing waters of the state, and withdrawal of certain federal water quality criteria applicable to California, New Jersey, and Puerto Rico. Therefore, protectiveness is not affected.	No active sediment remediation is occurring. A monitoring program is in place to provide visual inspections, hydrographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway.	December 2010, March 2012, July 2012, August 2012, April 2013, September 2014
Washington Water Pollution Control Act (WPCA); Washington State Water Quality Standards for Surface Water	State – WPCA – Water Pollution Control (RCW 90.48); WPCA Water Quality Standards for Surface Waters (WAC 173-201A)	Narrative and quantitative limitations for surface water protection are provided in these regulations. Criteria are established for each water classification, including fecal coliform, total dissolved gas, total dissolved oxygen, temperature, pH, and turbidity. During sediment remediation, discharges to marine surface waters will comply with these requirements.	The WAC 173-201A amendment corrected several language errors and revised some text and tables that needed more clarity. However, none of the changes affect protectiveness.	No active sediment remediation is occurring. A monitoring program is in place to provide visual inspections, hydrographic and topographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway.	May 2011

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Washington State Sediment Management Standards	State – Sediment Management Standards (RCW 43.21C, 70.105D, 90.48, 90.52, 90.54, 90.70; WAC 173-204)	Numerical and narrative criteria for chemicals and biological effects are specified for sediment and are applicable to Harbor Island shipyard sediments.	WAC 173-204 (Sediment Management Standards or SMS) was revised in 2013. The marine sediment cleanup objective (SCO) benthic protection values under the 2013 SMS are the same as the 1991 SQS values used in developing the LSS-OU7 cleanup levels for protection of benthic invertebrates. The requirements for protection of human health and higher trophic-level species are consistent with MTCA, which was promulgated in 1990, prior to the date of the LSS-OU7 ROD.	No active sediment remediation is occurring. A monitoring program is in place to provide visual inspections, hydrographic and topographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway.	February 2013
National Pollutant Discharge Elimination System (NPDES); Washington State Discharge Permit Program	Federal – NPDES (40 CFR 122, 125); State – NPDES (WAC 173-216, -220)	Applies to direct discharges to surface water conducted as part of remedial actions. Conditions to authorizing direct discharges to surface water are specified under 40 CFR 122. Criteria and standards for discharges are specified in 40 CFR 125. The State of Washington has been authorized by the EPA to implement the NPDES permit program.	None of the changes to the NPDES regulations affect protectiveness of the remedy.	No active sediment remediation is occurring. A monitoring program is in place to provide visual inspections, hydrographic and topographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway. Stormwater is discharged directly to the West	40 CFR 122: July 2012, December 2012, June 2013, August 2014, September 2014; 40 CFR 125: August 2014

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
				Waterway.	
Solid Waste Disposal Act; Washington State Minimum Functional Standards for Solid Waste Handling	Federal – Solid Waste Disposal (42 USC 3251; 40 CFR 257, 258); State – Solid Waste Handling (WAC 173-304)	Wastes generated by the remedial action include dredged sediment and sandblast grit, which is separated from dredged sediment. Sandblast grit may be suitable for recycling as feedstock for cement production.	The 40 CFR 258 amendments pertain to Solid Waste Landfill Permit Programs in Alaska, Massachusetts, and Oregon. Therefore, protectiveness is not affected.	No active sediment remediation is occurring. A monitoring program is in place to provide visual inspections, hydrographic and topographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway. Solids are removed from stormwater runoff.	40 CFR 258: January 2011, January 2013, April 2013
Storm water Management Program	Federal – Water Programs (40 CFR 122 -124); State – Water Pollution Control (RCW 90.48)	TBC - This describes storm water management objectives that may apply to storm drains at LSS-OU7.	None of the changes to the regulations affect protectiveness of the remedy.	No active sediment remediation is occurring. A monitoring program is in place to provide visual inspections, hydrographic and topographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway.	40 CFR 122: July 2012, December 2012, June 2013, August 2014, September 2014; 40 CFR 124: December 2010, September 2011, January 2013

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Puget Sound Estuary Program Protocols	Local – Puget Sound Partnership	TBC - Provides sample collection, laboratory analysis, and QA/QC procedures for sampling and analyzing sediment samples.	Protectiveness is not affected.	A monitoring program is in place to provide visual inspections, hydrographic and topographic surveys, monitor sediment quality, and the quality of groundwater entering the West Waterway.	None

Changes in Exposure Pathways

Land use at the site remains industrial and there are no expected land use changes in the future. The ecological exposure assumptions and toxicity data have not changed.

The human health risks, assessed based on exposure scenarios including Tribal consumption of seafood and direct contact and accidental ingestion by fishers, were below the level of concern that would require further investigation to determine whether remedial action for protection of human health should be taken. This risk assessment was based on data from the West Waterway as a whole, which included the LSS-OU7 and TSS-OU9. The exposure assumptions and toxicity data used to assess human health risks have changed. In August 2007, EPA Region 10 issued a "Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia" (EPA 2007; referred to as the Framework). The Framework was designed to assist EPA Region 10 with managing hazardous waste cleanup sites with Tribal seafood consumption exposures and concerns. The primary focus of the Framework is on the performance of risk assessments and their input into risk-based cleanup decisions.

The human health risk assumptions made in the ROD for the Shipyard Sediments Operable Unit and applicable to the LSS-OU7 were based on a tribal consumption scenario determined prior to EPA Region 10's development of the Framework. The Framework provides more location-specific consumption survey data for tribal consumption of seafood. The tribal consumption rates used for the risk assessment applicable to the LSS-OU7 represented national consumption rates, which are lower than the rates determined by the consumption survey data. Therefore, the risk to Tribal consumers of seafood may be greater than the risk levels presented in the RODs for the West Waterway and the Shipyard Sediment OUs. The Framework also emphasizes consultation with affected Tribes, whose fish consumption patterns can differ markedly. Formal consultation occurred with affected Tribes on November 16, 2009. At that meeting, representatives of the Muckleshoot Indian Tribe and Suquamish Tribe expressed that the Tribal Framework be brought into the Agency's decision regarding protectiveness. EPA has decided that reassessing the Tribal risk is unnecessary because the sediment cap will be protective in the long-term.

There were no human health cleanup levels, but appropriate cleanup levels may be needed if risks to human health are determined to be of concern. Additionally, because the ROD and subsequent ESDs did not identify a concern for human health, RAOs regarding human health were not developed. EPA has determined that reassessing the tribal risk will not lead to any changes in the remedy because the sediment cap is in place and preventing exposure.

Changes in Toxicity and Other Contaminant Characteristics

The toxicity data used to assess ecological health risks have not changed.

Changes in Risk Assessment Methods

Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs

RAOs in the ROD and the subsequent ESDs were to reduce concentrations of hazardous substances to levels that will have no adverse effect on marine organisms.

At the LSS-OU7, contaminated sediments were either dredged to native clean sediments or capped. Both remedial actions prevent exposure to humans, fish, shellfish, etc., either by removing the contaminated sediments or capping contaminated sediments remaining in place, and absent deposition of contaminated sediments from outside the remedial action area, should be fully protective over its lateral extent. Based on post-cleanup sediment sampling of the cap and dredged area, all COCs, except mercury and PCBs, were undetected. Recent sediment concentrations of mercury and PCBs were above the SCO in a few locations, likely due to deposition from other sources. The top-down trend needs be confirmed in future annual sampling events. These trends are expected to be confirmed before the next FYR. If the trends are confirmed, EPA will work with the PRPs regarding further investigation.

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

No other information has come to light that could call into question the protectiveness of the remedy.

7.4.4. Technical Assessment Summary

The remedy is functioning as intended by the decision documents and upland sources are not recontaminating the cap. However, there may be off-site sources that are depositing a fine layer of contaminated sediment in the open-channel area. Sediment contaminant concentrations have generally been below cleanup levels; recent mercury and total PCB exceedances in the open channel area may be traced to top-down sources of fine-grained sediments; that is, the contaminant exceedances may be traced to sediment from outside sources deposited from suspension onto the cover. This top-down nature of this contamination should be evaluated in future sampling events. The various areas of the sediment remedy have undergone little to no elevation changes since the implementation of the remedy. Groundwater monitoring data show that concentrations of copper, nickel, and zinc exceeding NRWQC are present along the shoreline. An evaluation of equilibrium partitioning indicates that the cap will not be recontaminated due to the observed levels of contamination in groundwater. Zinc and mercury have been detected in solids collected from the stormwater treatment system that discharges onto the cap. Additional actions (including collection of additional sediment samples at the discharge point) are required to determine whether contaminated sediments are being deposited on the cap near the discharge point. ICs were not specified in the ROD, but the OMMP requires the PRP to maintain site access and required ICs, including establishing a USCG RNA. The RNA was established in 2012 to protect capped areas.

Cleanup standards and exposure pathways have not changed in a way that affects protectiveness.

7.5. Todd Shipyard Sediments OU9

7.5.1. Question A. Is the remedy functioning as intended by the decision documents?

Yes. Results from the latest annual monitoring event indicates that the remedy is functioning as intended by the decision documents for both the dredged and capped areas. Annual monitoring indicates that the capped areas are intact and do not appear to be subject to erosion. Evidence of fines and shell debris has settled on the surface of the caps indicating that erosion has not taken place.

Remedial Action Performance

The most recent physical integrity monitoring showed no evidence of complete cap erosion. The cap has remained in place and is functioning as intended.

System Operations/O&M

Physical integrity monitoring was conducted once in the last five years. Results indicated that capping materials have stayed in place and the cap is not significantly eroding. Monitoring is now completed every five years, and the next monitoring event (Year 9) is expected to be completed sometime in 2016. Sediment chemistry monitoring has not been completed since the cap was placed. Future sampling should include sediment chemistry monitoring.

Opportunities for Optimization

No opportunities for optimization were identified.

Early Indicators of Potential Issues

Significant accumulation of silt and shell debris in the under-pier capped areas may make observation of cap material difficult during future monitoring events.

Implementation of Institutional Controls and Other Measures

Specific institutional controls beyond best management practices and review of permit applications through the USACE need to be implemented. Before the next FYR, an IC study should be completed and ICs implemented and maintained if necessary to ensure the long-term protectiveness of the remedy.

7.5.2. Question B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid??

Yes. The exposure assumptions and toxicity data used at the time of the remedy selection have changed. However, no change to remedy protectiveness is expected because the sediment cap is in place and preventing exposure.

Changes in Standards and TBCs

The remedial action required for the TSS-OU9 was based on the presence of unacceptable risks to benthic organisms. Cleanup levels for the protection of benthic organisms were derived from Ecology regulations for sediment cleanups. A summary of the ARARs evaluation for TSS-OU9 is provided in Table 41. The table does not include those that are no longer pertinent. For example, ARARs related to remedial design and construction are not included in the table if they do not continue into long-term operations and maintenance.

Table 41. TSS-OU9, ARAR Evaluation

Requirement	Citation	Description	Effect on Protectiveness	Comments	Amendment Date
Water Quality Standards	Federal – Water Quality Standards (33 USC 1251; 40 CFR 131);	Federal criteria for the protection of marine aquatic life are relevant and appropriate for discharges to surface water during sediment remediation.	The amendments pertain to water quality standards in Florida for the Everglades and flowing lakes and flowing waters of the state, and withdrawal of certain federal water quality criteria applicable to California, New Jersey, and Puerto Rico. Therefore, protectiveness is not affected.	No active sediment remediation is occurring. Only visual monitoring of the cap and the previous dredged channel is occurring.	December 2010, March 2012, July 2012, August 2012, April 2013, September 2014
Washington Water Pollution Control Act (WPCA); Washington State Water Quality Standards for Surface Water	State – WPCA – Water Pollution Control (RCW 90.48); WPCA Water Quality Standards for Surface Waters (WAC 173-201A)	Narrative and quantitative limitations for surface water protection are provided in these regulations. Criteria are established for each water classification, including fecal coliform, total dissolved gas, total dissolved oxygen, temperature, pH, and turbidity. During sediment remediation, discharges to marine surface waters will comply with these requirements.	The WAC 173-201Aamendment corrected several language errors and revised some text and tables that needed more clarity. However, none of the changes affect protectiveness.	No active sediment remediation is occurring. Only visual monitoring of the cap and the previous dredged channel is occurring.	May 2011
Washington State Sediment Management Standards	State – Sediment Management Standards (RCW 43.21C, 70.105D, 90.48, 90.52, 90.54, 90.70; WAC 173-204)	Numerical and narrative criteria for chemicals and biological effects are specified for sediment and are applicable to Harbor Island shipyard sediments.	WAC 173-204 (Sediment Management Standards or SMS) was revised in 2013. The marine sediment cleanup objective (SCO) benthic protection values under the 2013 SMS are the same as the 1991 SQS values used in developing the LSS-OU7 cleanup levels for protection of benthic invertebrates. The requirements for protection of human health and higher trophic-level species are consistent with MTCA, which was promulgated in 1990, prior to the date of the LSS-OU7 ROD.	No active sediment remediation is occurring. Only visual monitoring of the cap and the previous dredged channel is occurring.	February 2013

Changes in Exposure Pathways

Land use at the site remains industrial and there are no expected land use changes in the future. The ecological exposure assumptions and toxicity data have not changed.

The human health risks, assessed based on exposure scenarios including Tribal consumption of seafood and direct contact and accidental ingestion by fishers, were below the level of concern that would require further investigation to determine whether remedial action for protection of human health should be taken. This risk assessment was based on data from the West Waterway as a whole, which included the LSS-OU7 and TSS-OU9. The exposure assumptions and toxicity data used to assess human health risks have changed. In August 2007, EPA Region 10 issued a "Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia" (EPA 2007; referred to as the Framework). The Framework was designed to assist EPA Region 10 with managing hazardous waste cleanup sites with Tribal seafood consumption exposures and concerns. The primary focus of the Framework is on the performance of risk assessments and their input into risk-based cleanup decisions.

The human health risk assumptions made in the ROD for the Shipyard Sediments Operable Unit and applicable to the LSS-OU7 were based on a tribal consumption scenario determined prior to EPA Region 10's development of the Framework. The Framework provides more location-specific consumption survey data for tribal consumption of seafood. The tribal consumption rates used for the risk assessment applicable to the LSS-OU7 represented national consumption rates, which are lower than the rates determined by the consumption survey data. Therefore, the risk to Tribal consumers of seafood may be greater than the risk levels presented in the RODs for the West Waterway and the Shipyard Sediment OUs. The Framework also emphasizes consultation with affected Tribes, whose fish consumption patterns can differ markedly. Formal consultation occurred with affected Tribes on November 16, 2009. At that meeting, representatives of the Muckleshoot Indian Tribe and Suquamish Tribe expressed that the Tribal Framework be brought into the Agency's decision regarding protectiveness. EPA has decided that reassessing the Tribal risk is unnecessary because the sediment cap will be protective in the long-term.

There were no human health cleanup levels, but appropriate cleanup levels may be needed if risks to human health are determined to be of concern. Additionally, because the ROD and subsequent ESDs did not identify a concern for human health, RAOs regarding human health were not developed. EPA has determined that reassessing the tribal risk will not lead to any changes in the remedy because the sediment cap is in place and preventing exposure.

Changes in Toxicity and Other Contaminant Characteristics

The toxicity data used to assess ecological health risks have not changed.

Changes in Risk Assessment Methods

Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs

RAOs in the ROD and the subsequent ESDs were to reduce concentrations of hazardous substances to levels that will have no adverse effect on marine organisms.

At the TSS-OU9, contaminated sediments were either dredged to native clean sediments or capped. Both remedial actions prevent exposure to fish and shellfish either by removing the contaminated sediments or capping contaminated sediments remaining in place and absent recontamination should be fully protective over its lateral extent. Sediment samples were not taken in the last five years because there was no evidence of cap erosion. Because the cap remains in place and stable, contaminant exposure to marine organisms is expected to be minimal or non-existent. Applicable areas of the TSS-OU9 have been well-colonized by marine life.

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

No other information has come to light that could call into question the protectiveness of the remedy.

7.5.4. Technical Assessment Summary

Results from the latest annual monitoring event indicates that the remedy is functioning as intended by the decision documents for both the dredged and capped areas. At the TSS-OU9, contaminated sediments were either dredged to native clean sediments or capped. Both remedial actions prevent exposure to fish and shellfish either by removing the contaminated sediments or capping contaminated sediments remaining in place and absent recontamination should be fully protective over its lateral extent. Sediment samples were not taken in the last five years because there was no evidence of cap erosion. Because the cap remains in place and stable, contaminant exposure to marine organisms is expected to be minimal or non-existent. Applicable areas of the TSS-OU9 have been well-colonized by marine life.

Cleanup standards and exposure pathways have not changed in a way that affects protectiveness. No institutional controls were specified in the ROD, subsequent ESDs, or the CD for the TSS-OU9. Specific institutional controls beyond best management practices and review of permit applications through the USACE have not been implemented nor has an Institutional Controls

Study been completed. ICs need to be implemented and maintained to ensure the long-term function and protectiveness of the remedy.

8. Issues/Recommendations and Follow-up Actions

Table 42. Issues and Recommendations/Follow-up Actions

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
1&3	Appropriate restrictive covenants are not in place for all required properties.	Record completed UECA covenants on required properties.	Steering Committee/ Lockheed/ EPA	EPA	September 2020	N	Y
1	Cap inspection and maintenance reporting is inconsistent.	Submit reports for all cap areas on a consistent basis.	Steering Committee	EPA	September 2016	N	Y
1	The LNAPL system at Todd Shipyards has been partially shut down, but long-term groundwater monitoring has not started.	Develop a groundwater monitoring program at Todd Shipyards to determine whether or not contamination is migrating to the waterway.	Todd Shipyards	EPA	September 2016	N	Y
2	Elevated COC concentrations and a lack of decreasing trends indicate that MNA may not be able to reach cleanup levels in the TX-03A area.	Evaluate full-scale active remediation at the area near well TX-03A and implement additional remediation if determined appropriate by Ecology in coordination with EPA.	Tank Farm Facility/ PLP	Ecology	September 2016	N	Y
7	Zinc and mercury have been detected above SCO criteria in solids in stormwater treatment effluent that discharges to the LSS-OU7 cap.	Evaluate the new BMPs or investigate sources and opportunities to ensure that stormwater contaminants are not discharging onto the LSS-OU7 cap.	POS	EPA	September 2016	N	Y
7	Fine-grained sediments collected during the most recent sampling event in the open-channel area	In future monitoring events, confirm whether or not the recent contamination can be	Lockheed	EPA	September 2017	N	Y

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
	have mercury and total PCB concentrations greater than their respective SCOs. A general increase in total fines has been observed over the last five years. It is possible that there is a fine top layer of sediment that has deposited on the open-channel surface from sources outside the LSS-OU7, which may be indicative of sediment from outside sources deposited from suspension onto the cover.	traced to sediment from outside sources deposited from suspension. If that occurs before the next FYR, EPA will work with the PRPs for future investigations.					
9	An evaluation of sediment chemistry has not been completed since the RA in 2007.	Collect sediment samples to ensure that recontamination is not occurring.	PRP	EPA	September 2020	N	Y
9	Institutional Controls Study needs to be completed.	Conduct IC Study to evaluate the need for ICs. If warranted, include ICs in a decision document and implement the ICs.	PRP/EPA	EPA	September 2020	N	Y

In addition, the following items are recommended that could improve effectiveness of the remedy but do not affect current protectiveness and were identified during the FYR:

- At the S&G-OU1, comprehensive sampling detected a phthalate above NRWQC at one well. Bis(2-ethylhexyl)phthalate should be included in the analyte list for well MW-01 during the next sampling event to verify the detected value and determine if it is above the NRWQC.
- Complete hydrographic and topographic surveys for the LSS-OU7 in the year prior to the next FYR so that data can be included in the FYR analysis.

9. Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: S&G-OU1	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Soil and Groundwater OU1 currently protects human health and the environment because the LNAPL extraction system is actively removing the remaining product and long-term groundwater monitoring indicates that contaminants are not migrating to the waterways. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Complete Restrictive Covenants for all capped properties.
- Complete annual cap inspections consistently.
- Develop a groundwater monitoring program at Todd Shipyards to determine whether or not contamination is migrating to the waterway.

Protectiveness Statement(s)		
Operable Unit: TF-OU2	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Tank Farms OU2 currently protects human health and the environment because active remediation or MNA is treating contaminants. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Evaluate full-scale active remediation at the area near well TX-03A and implement additional remediation if determined appropriate by Ecology in coordination with EPA.

Protectiveness Statement(s)		
Operable Unit: LU-OU3	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Lockheed Upland OU3 currently protects human health and the environment because the cap integrity has been maintained and groundwater studies indicate that contaminants are not impacting the waterway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Complete Restrictive Covenants for capped areas of the property.

Protectiveness Statement(s)		
Operable Unit: LSS-OU7	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Lockheed Shipyard Sediments OU7 currently protects human health and the environment because the cap integrity has been maintained and groundwater studies indicate that contaminants are not impacting the waterway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Evaluate the new BMPs or investigate sources and opportunities to ensure that stormwater contaminants are not discharging onto the LSS-OU7 cap.
- In future monitoring events, confirm whether or not the recent contamination can be traced to sediment from outside sources deposited from suspension. If sources such as this exist, EPA will work with the PRP for additional investigations to ensure protectiveness.

Protectiveness Statement(s)		
Operable Unit: TSS-OU9	*Protectiveness Determination:* Short-Term Protective	*Addendum Due Date (if applicable):*

Protectiveness Statement:
The remedy at the Todd Shipyard Sediments OU9 currently protects human health and the environment because the cap integrity has been maintained. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness:

- Collect sediment samples to determine whether recontamination is occurring.
- Conduct an IC study to evaluate the need for ICs. If warranted, include ICs in a decision document and implement the ICs.

10. Next Review

The next five-year review report for the Harbor Island Superfund Site is required five years from the completion date of this review.

Appendix A: Figures

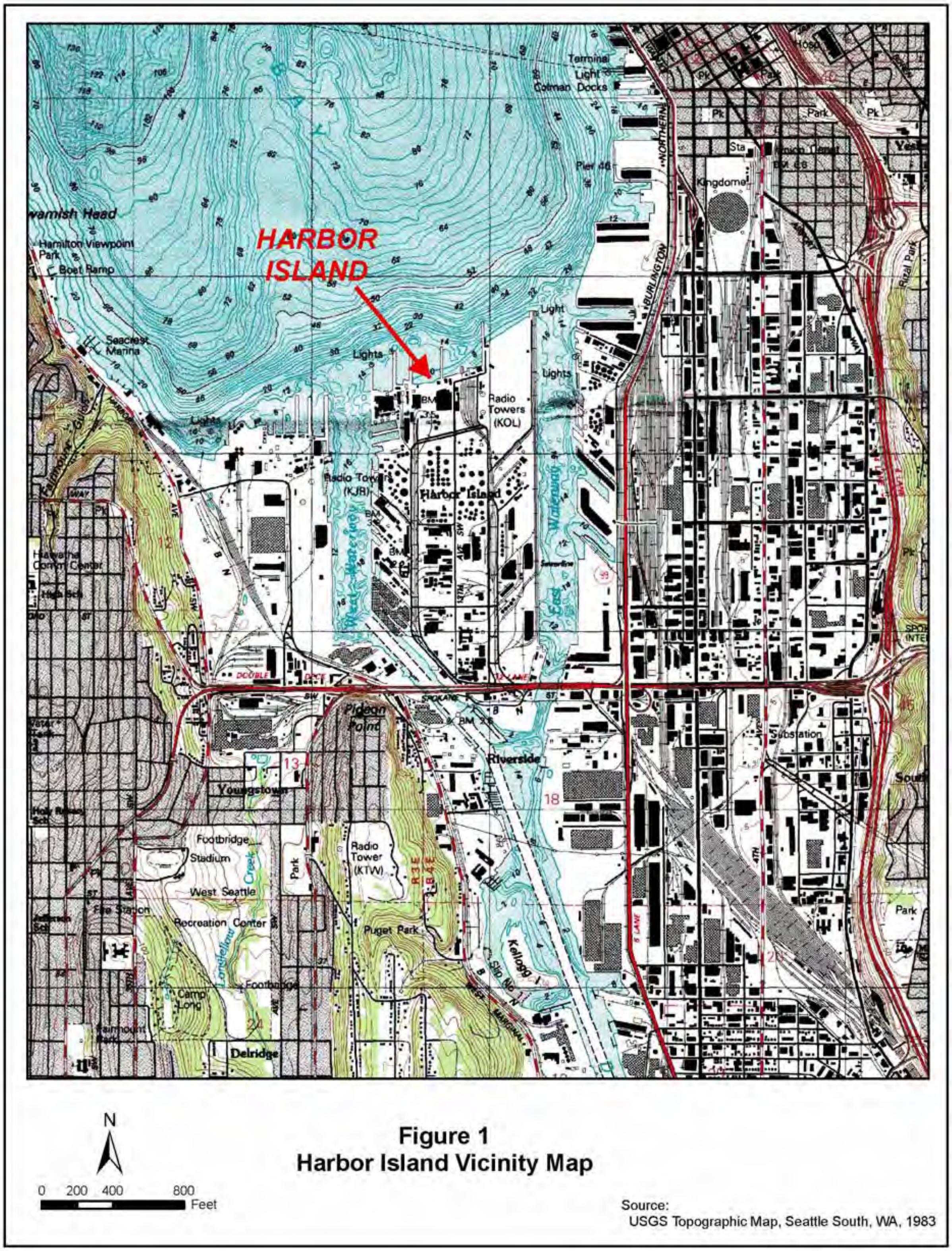


Figure 1. Harbor Island Vicinity Map

Figure 2. Harbor Island Operable Units

Figure 3. S&G-OU1 Capped Areas

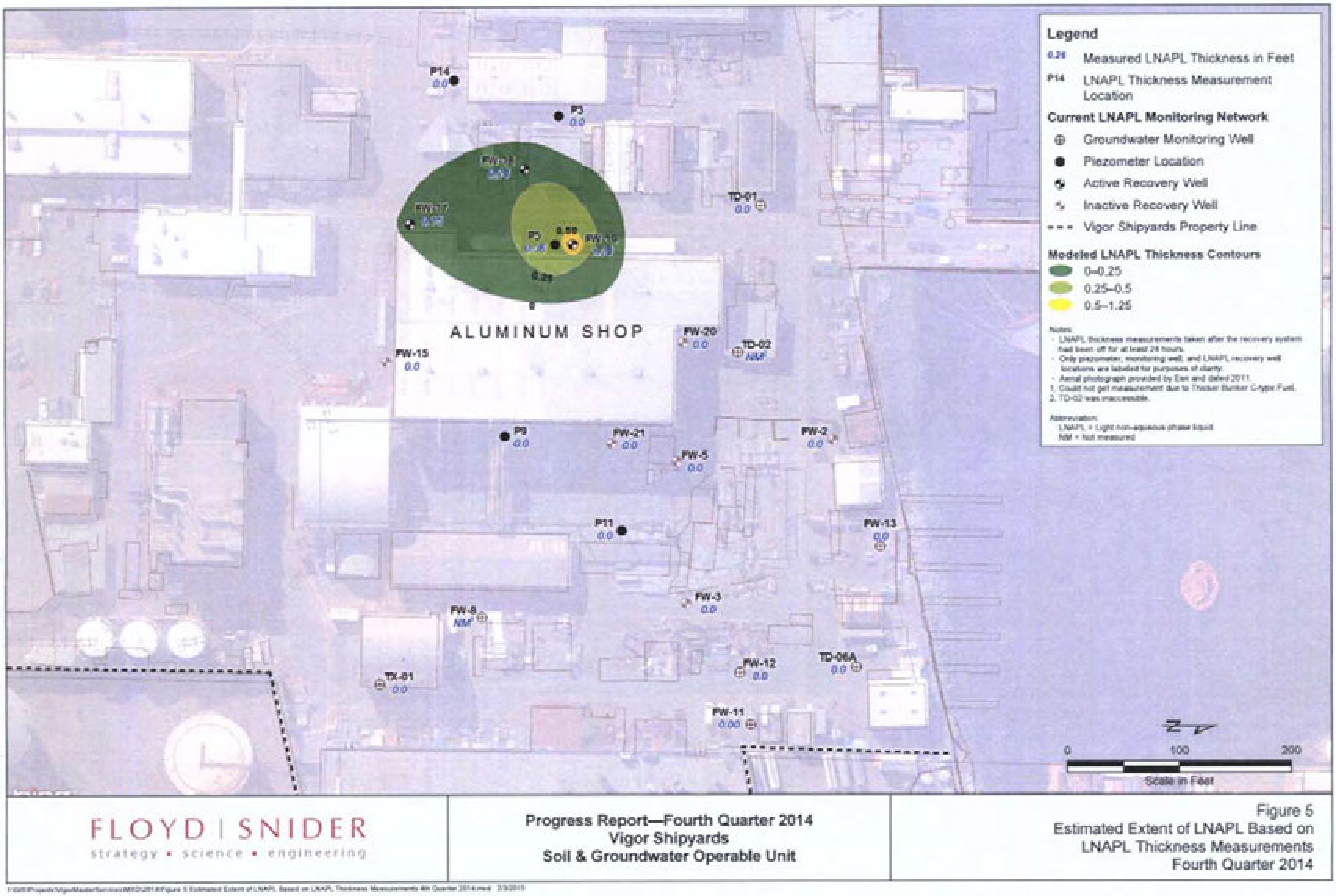


Figure 4. S&G-OU1, Todd Shipyard LNAPL Monitoring Network and LNAPL Extent

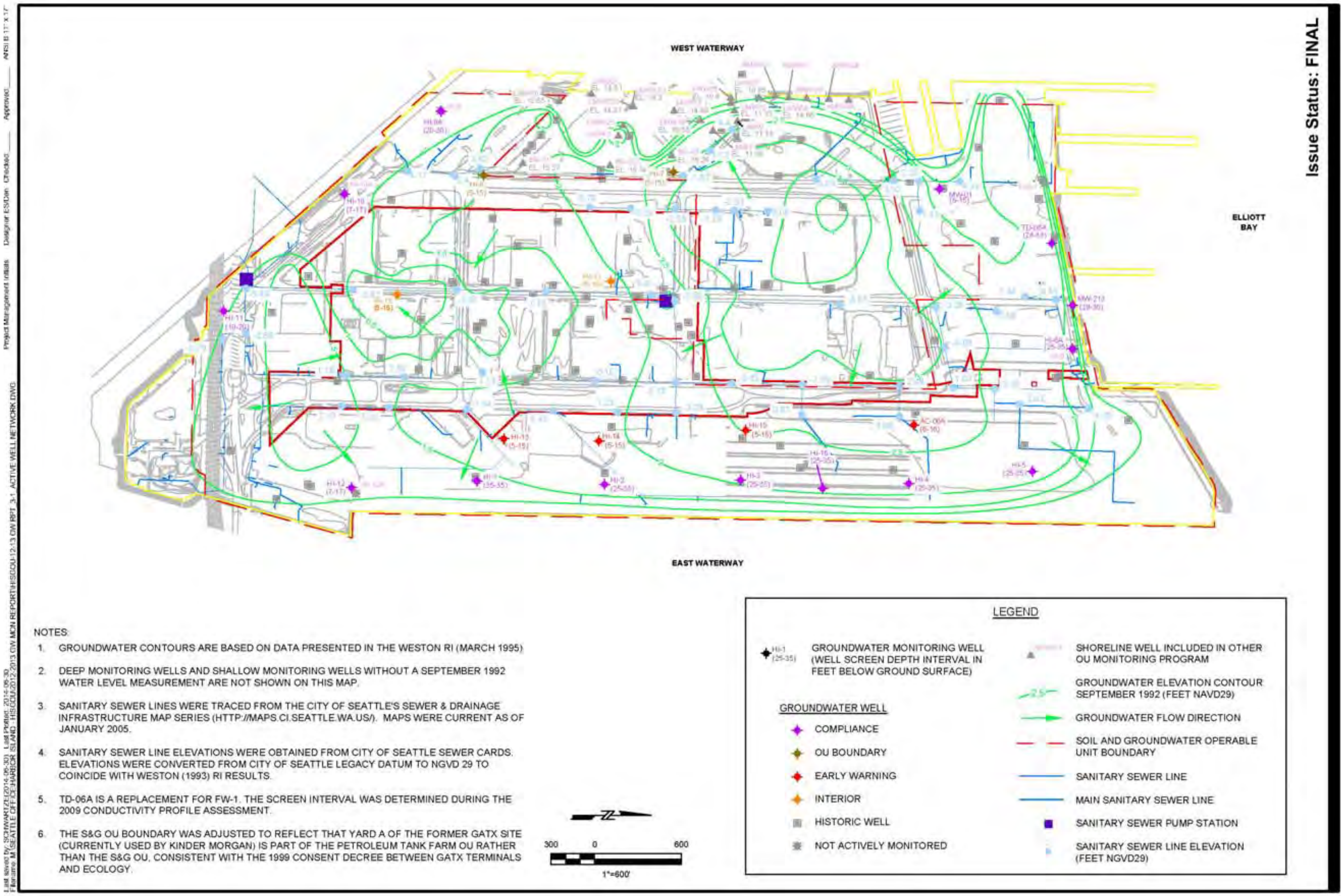


Figure 5. S&G-OU1, Monitoring Well Locations

Figure 6. TF-OU2, Tank Farm Facilities

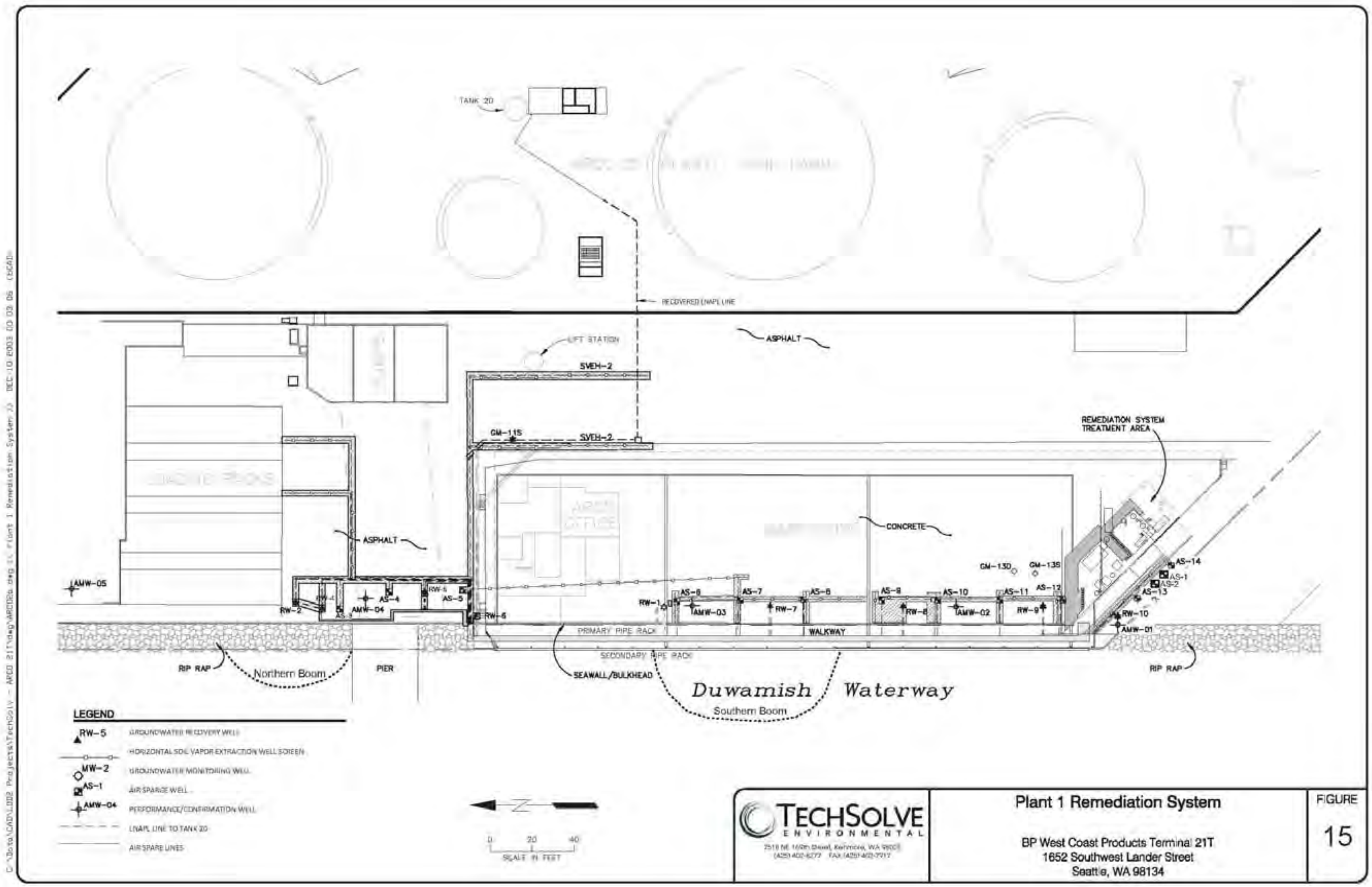


Figure 7. TF-OU2, BP Plant 1 Remediation Systems

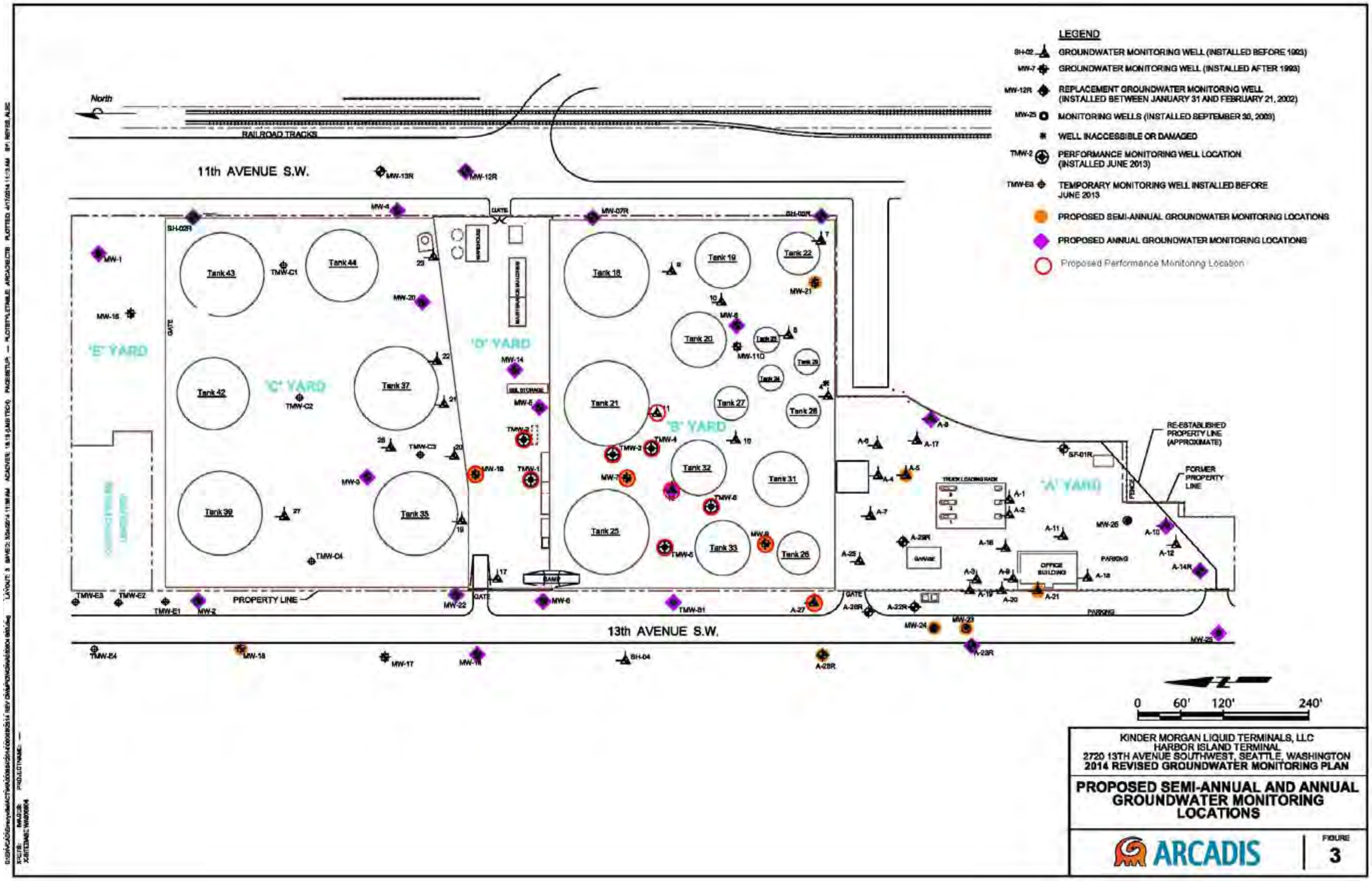


Figure 8. TF-OU2, Kinder Morgan Monitoring Well Locations

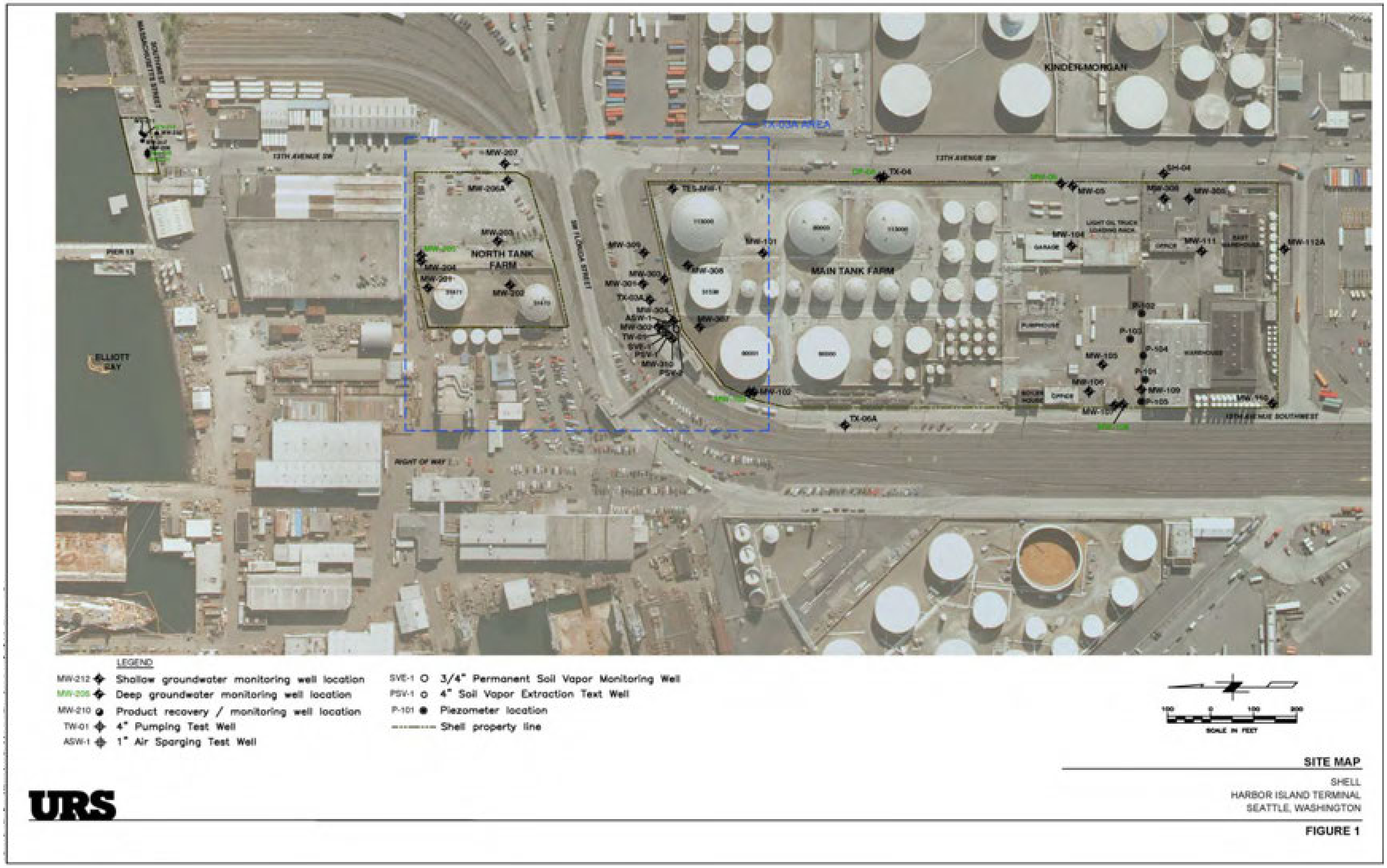


Figure 9. TF-OU2, Shell Monitoring Well Locations

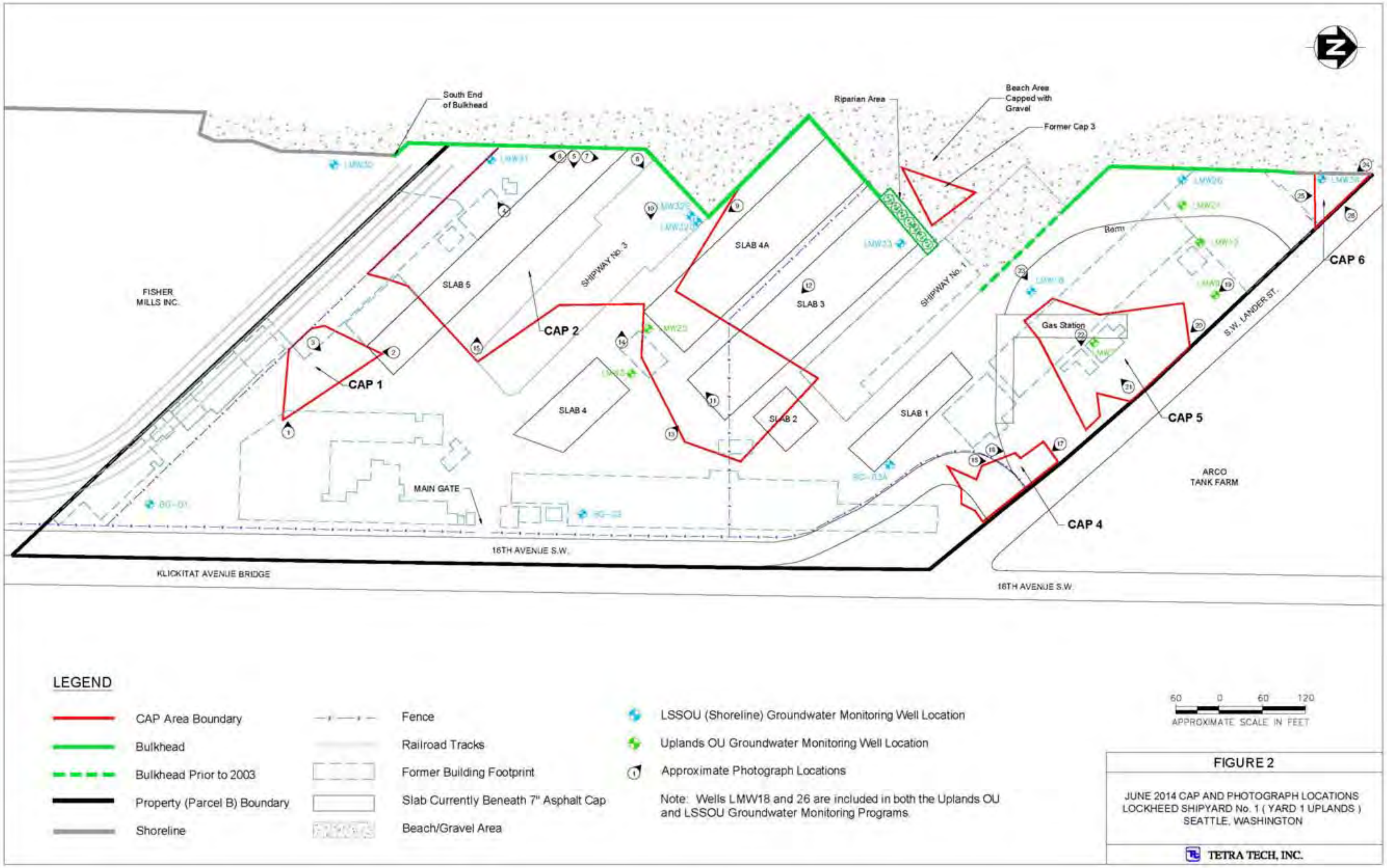


Figure 10. LU-OU3, Monitoring Well Locations and Capped Areas

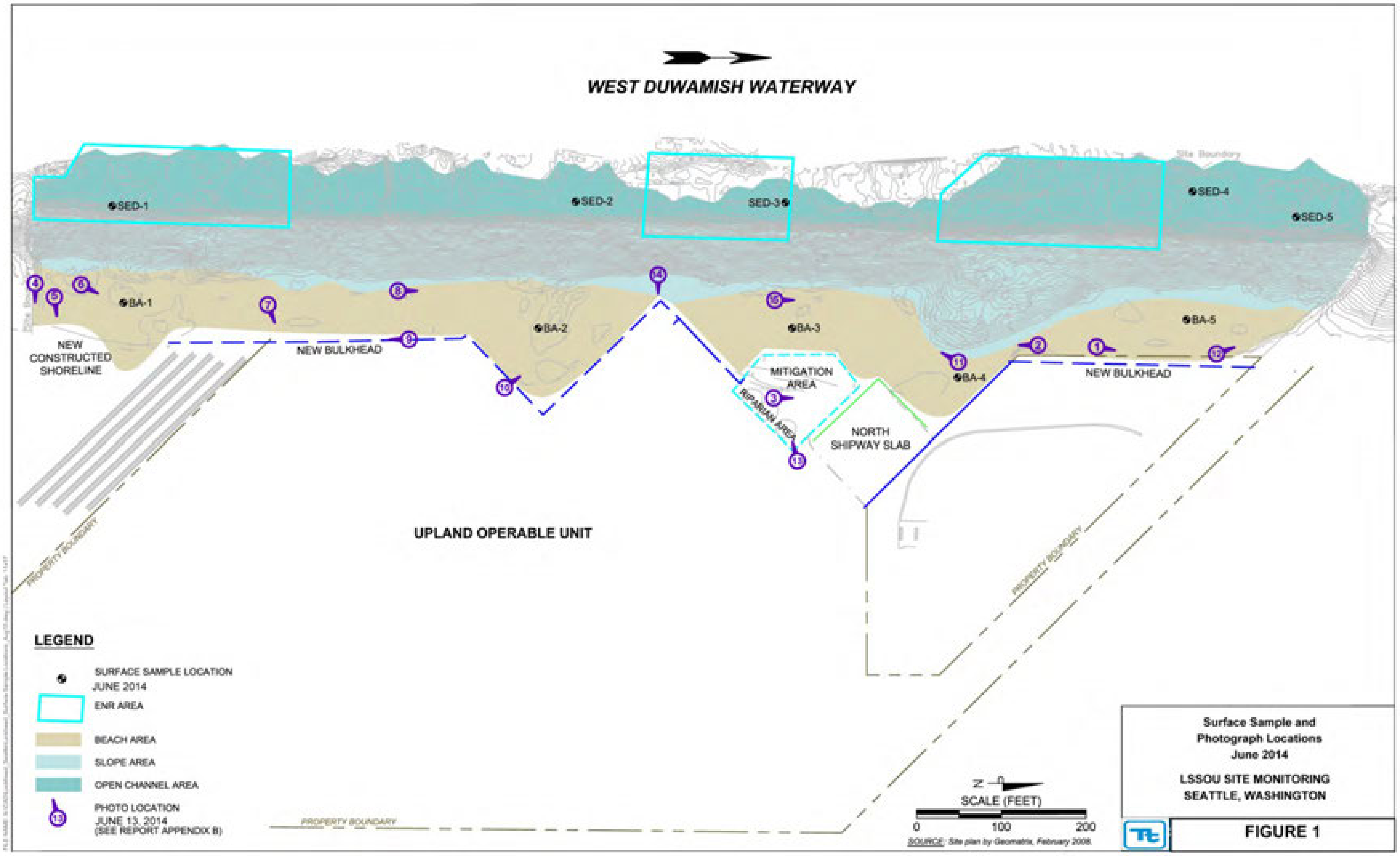


Figure 11. LSS-OU7, Surface Sample Locations

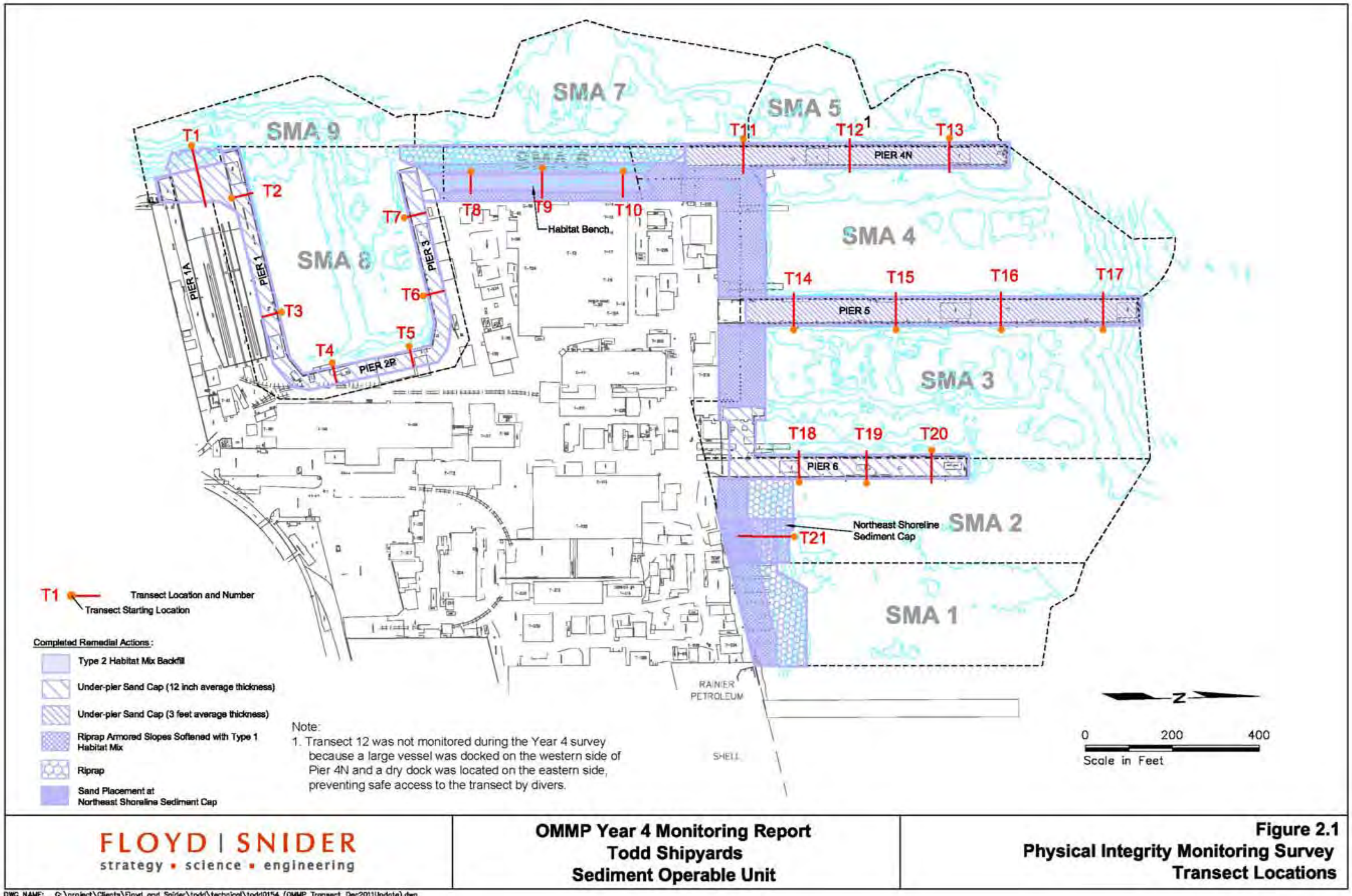


Figure 12. TSS-OU9, Monitoring Survey Locations

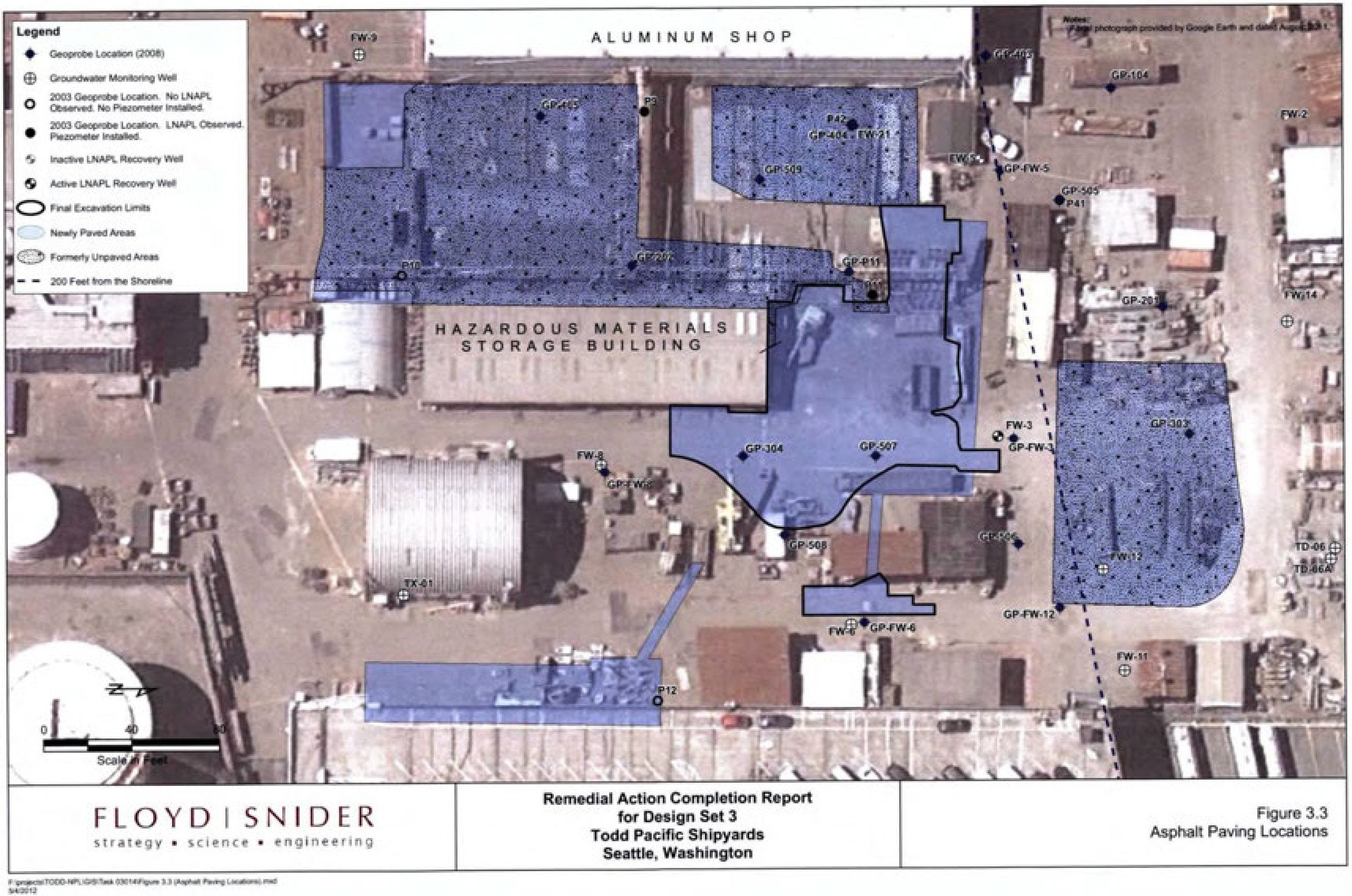


Figure 13. S&G-OU1, Todd Shipyard Excavation Extent and Cap Areas

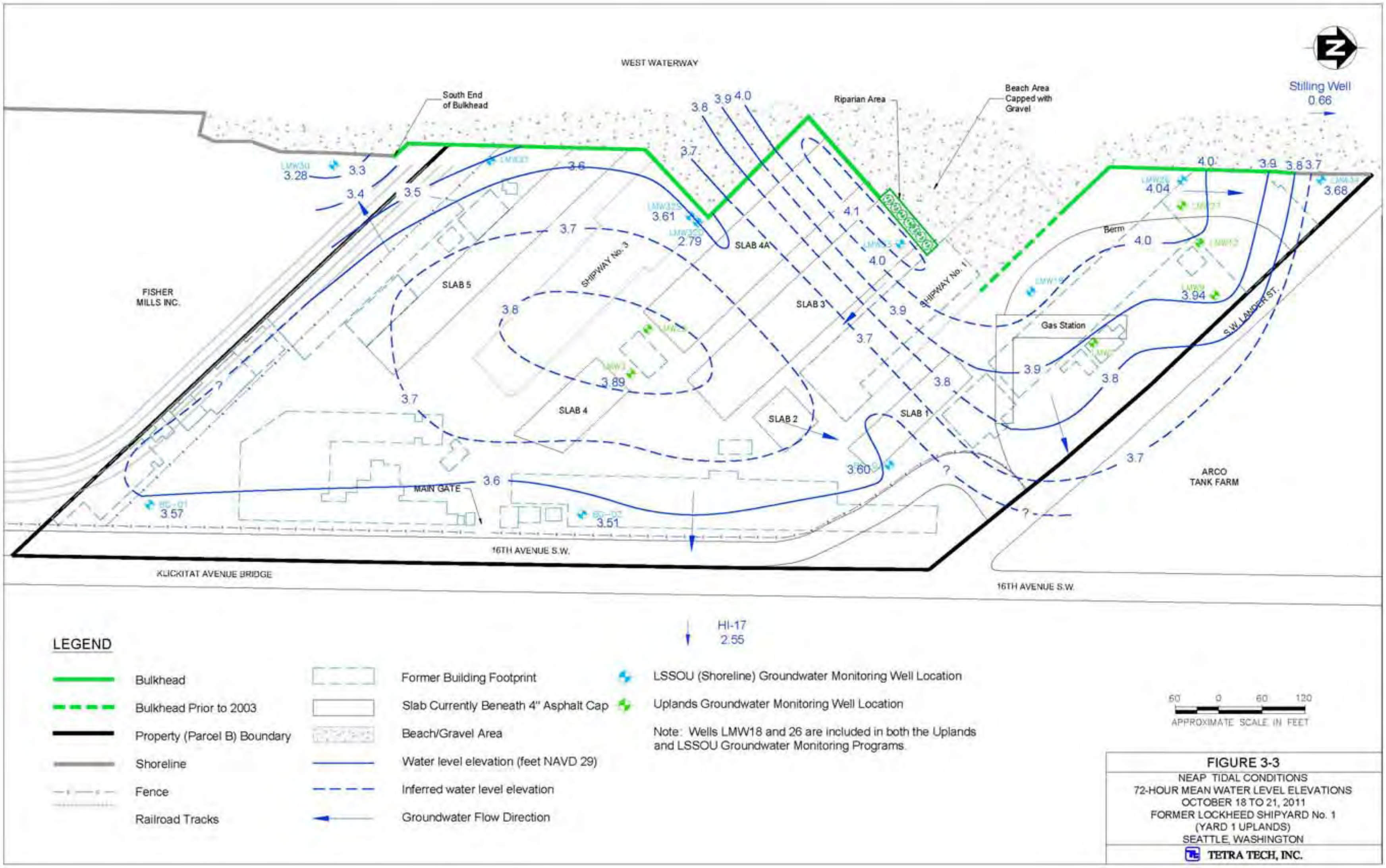


Figure 14. LU-OU3, Neap Tide Average Groundwater Elevations

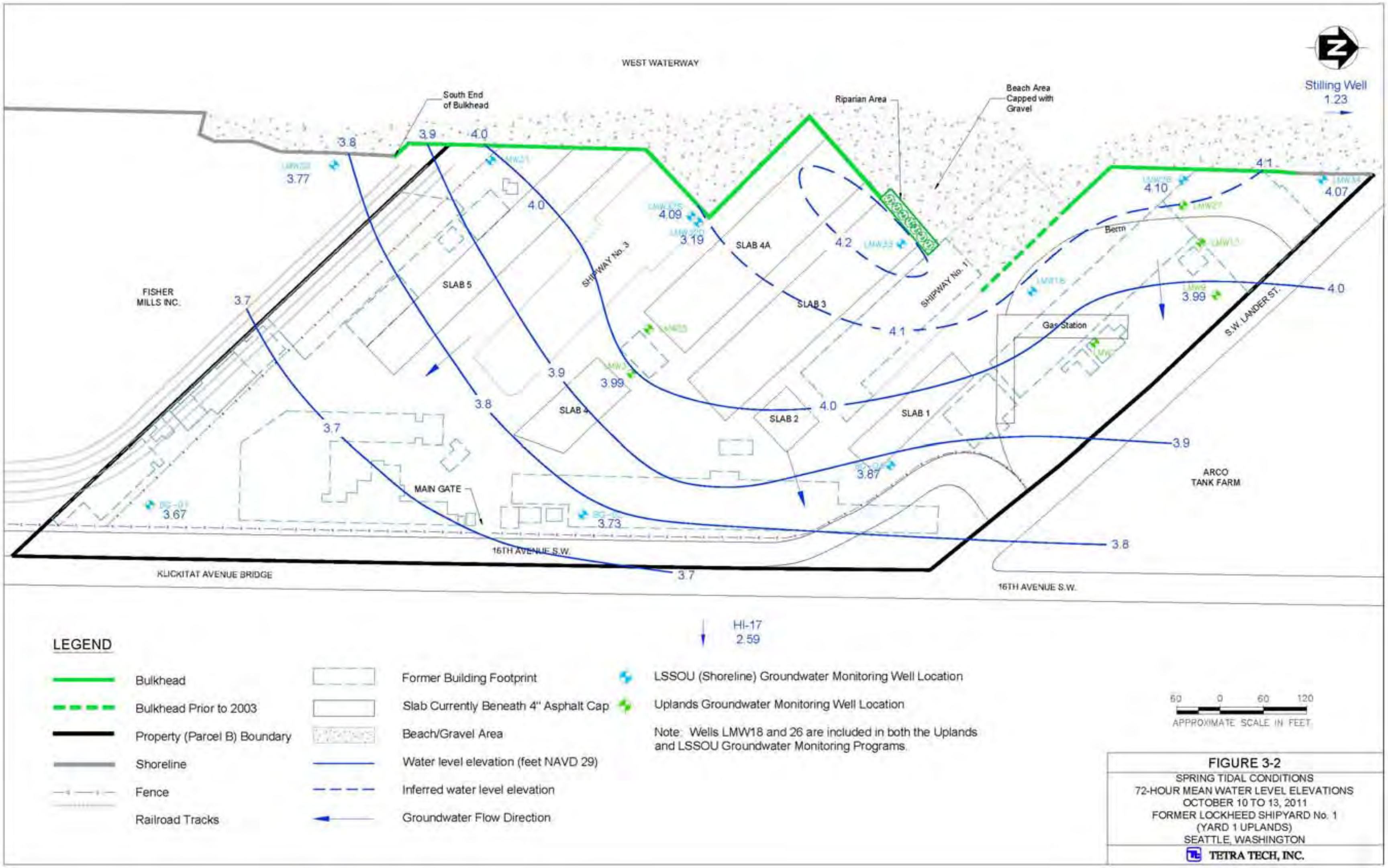
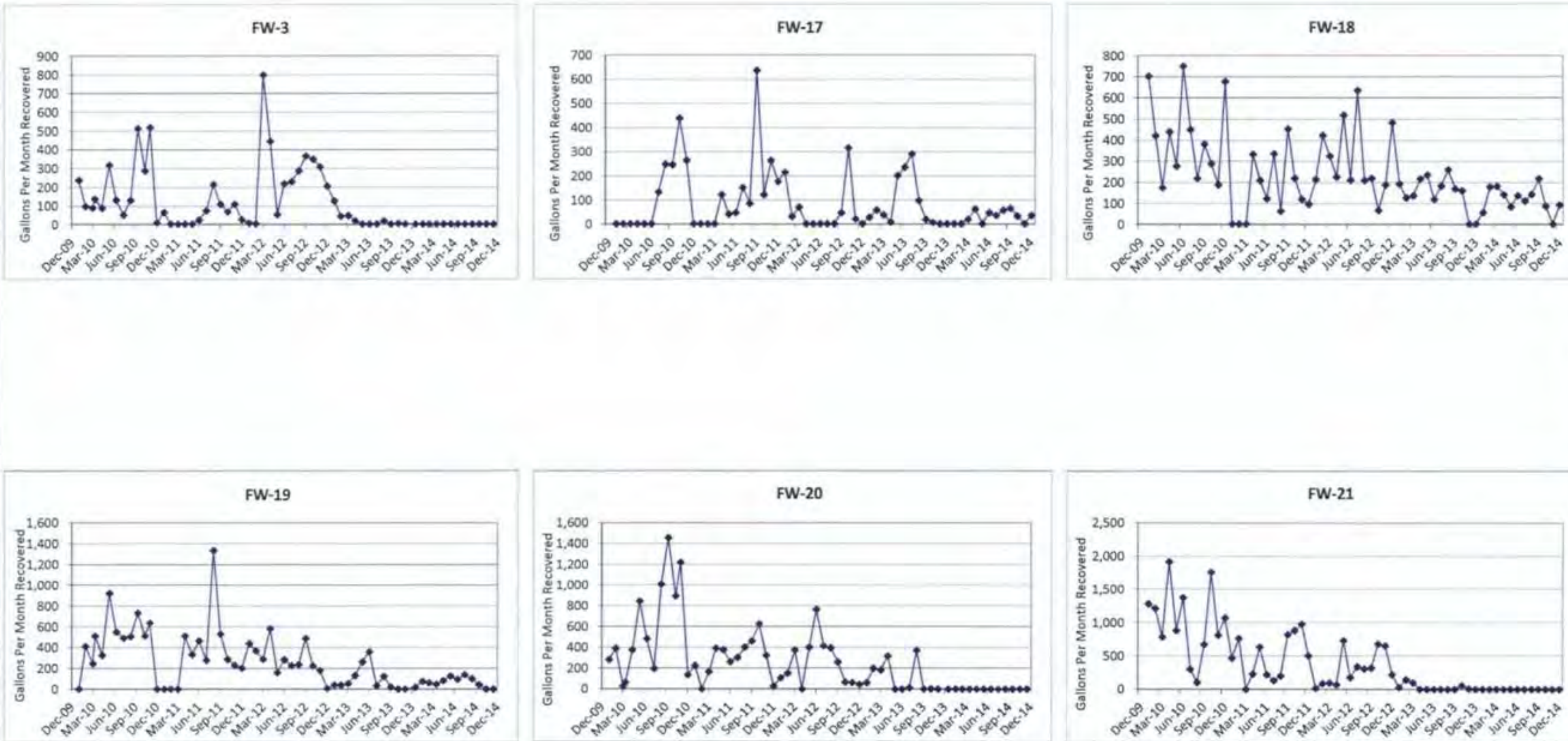


Figure 15. LU-OU3, Spring Tide Average Groundwater Elevations



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Vigor Shipyards
Soil & Groundwater Operable Unit

Figure 4
Active Recovery Wells, Monthly Recovery Rates,
January 1, 2010 to December 31, 2014

Figure 16. S&G-OU1, Todd Shipyard LNAPL Recovery Rates

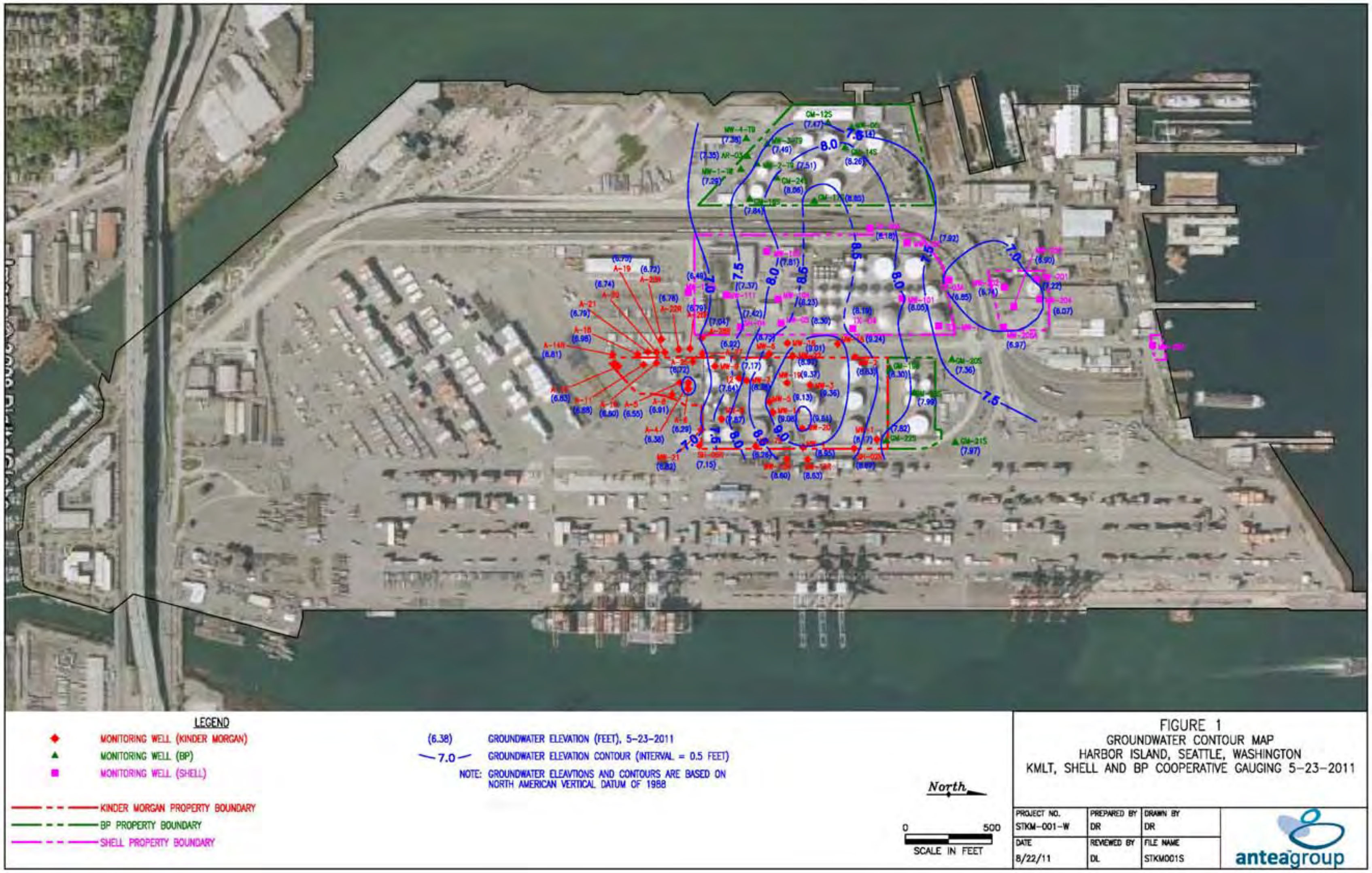

Figure 17 TF-OU2, Groundwater Elevation Contour Map

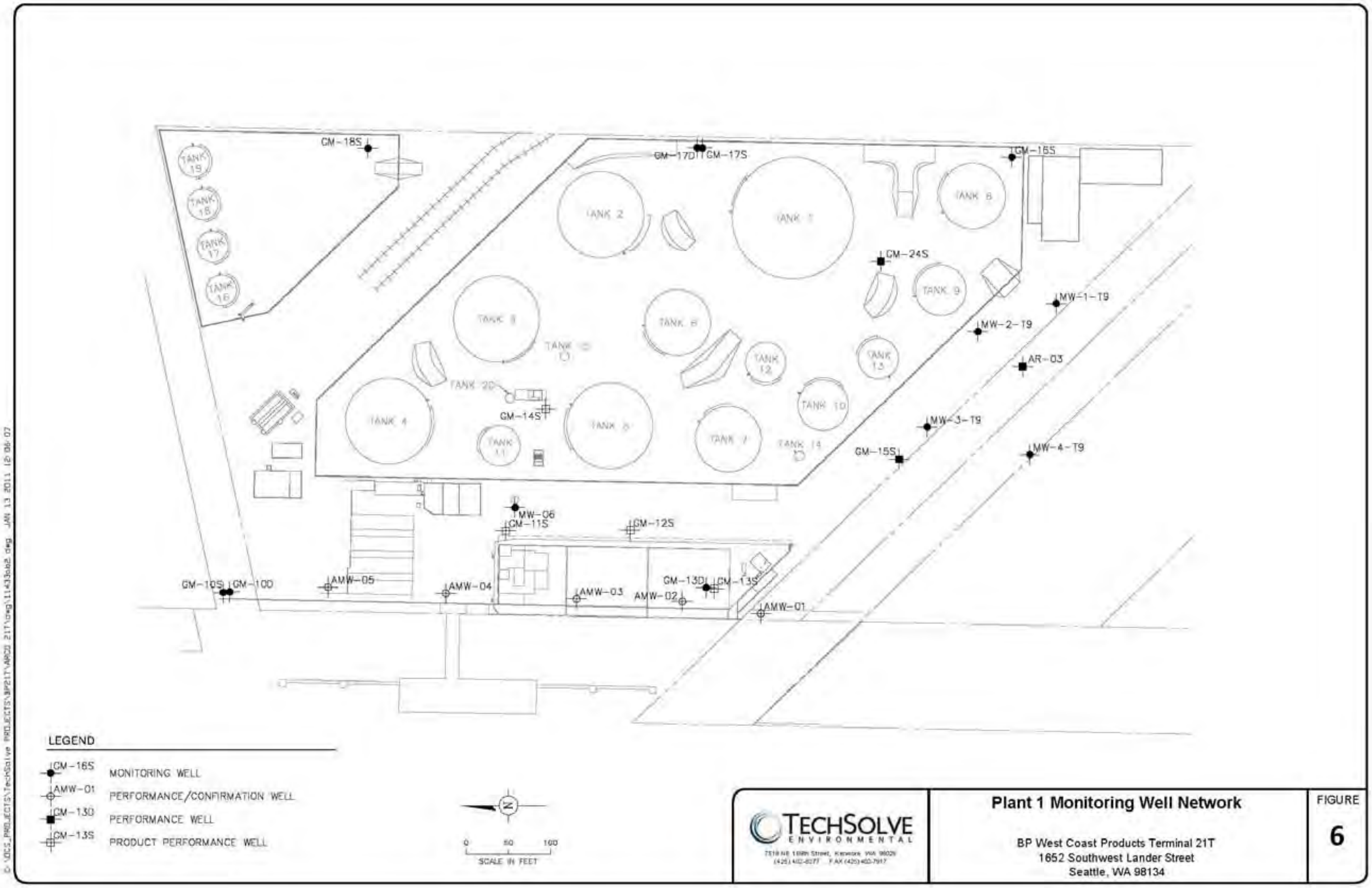

Figure 18. TF-OU2, BP Plant 1 Monitoring Well Locations

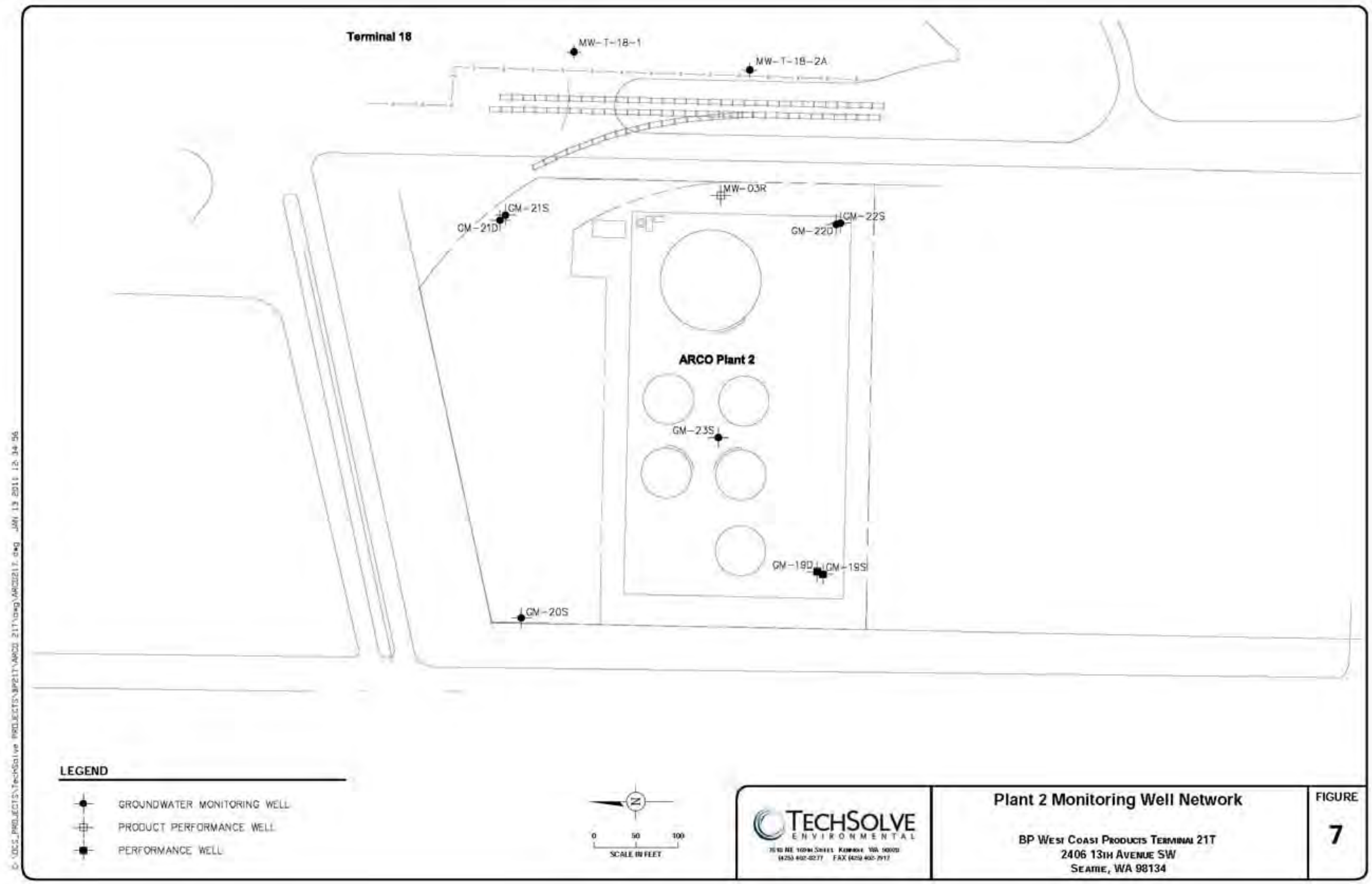

Figure 19. TF-OU2, BP Plant 2 Monitoring Well Locations

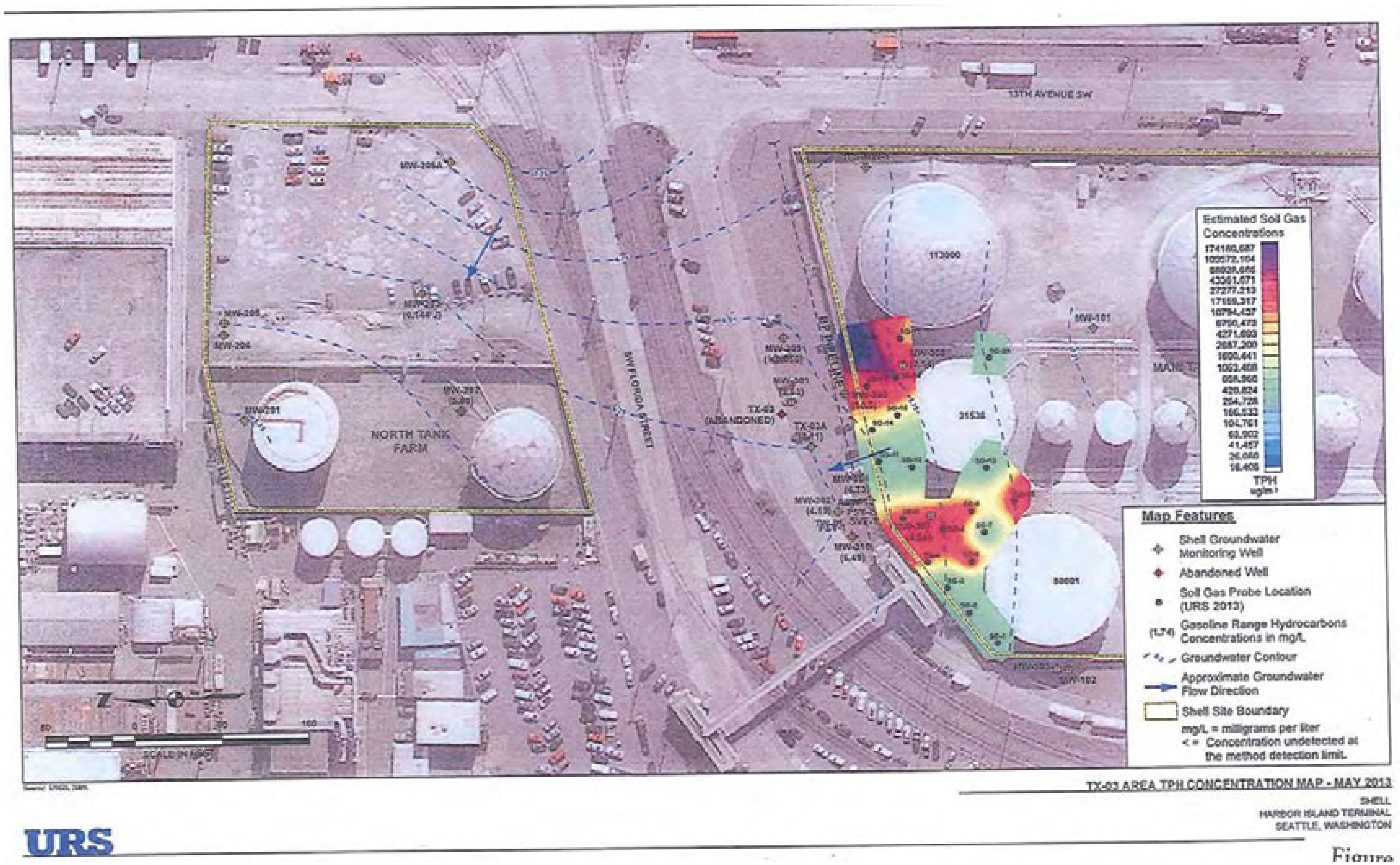

Figure 20. TF-OU2, Shell Soil Gas Concentrations at TX-03 Area

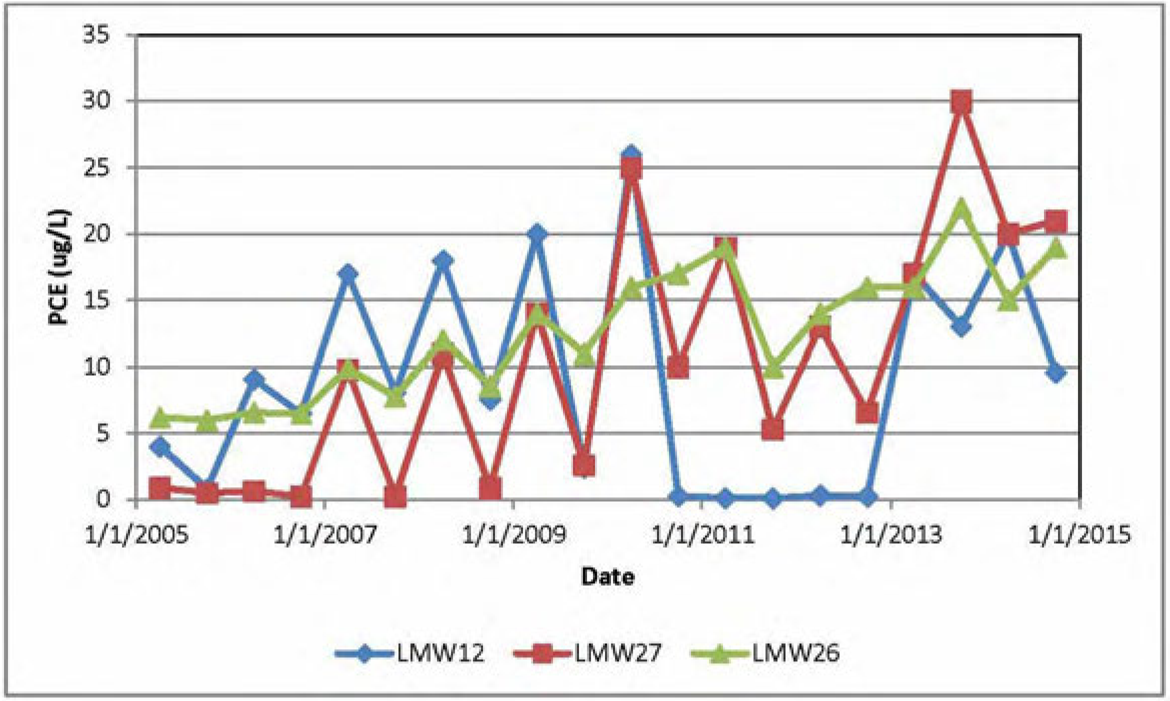

Figure 21. LU-OU3, PCE Concentrations over Time

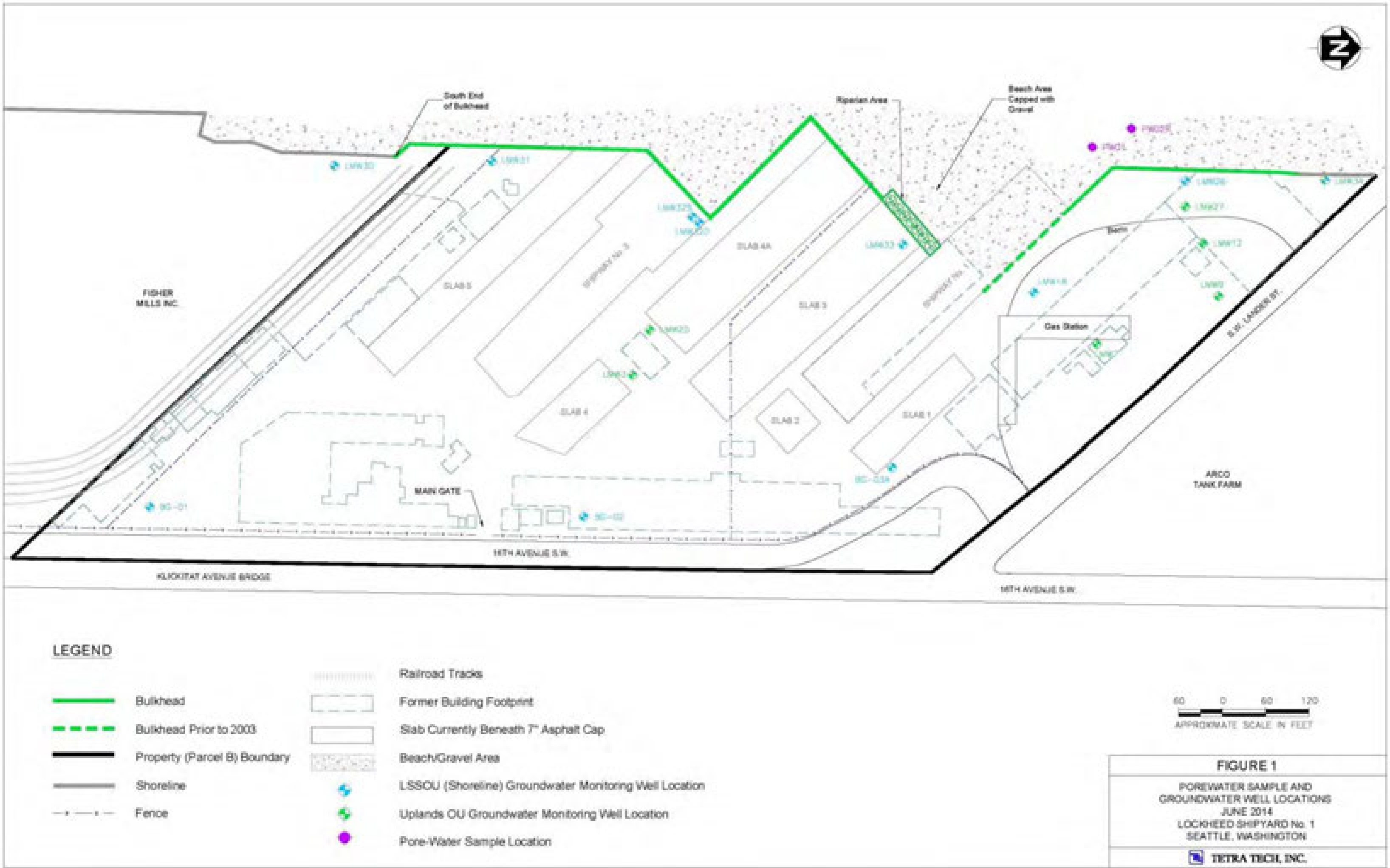

Figure 22. LU-OU3, Porewater Sampling Locations

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Appendix B: Data Tables

Table B-1. S&G-OU1, Summary of Semi-Annual Sampling

Well	Location	Available Cyanide (ug/L)		Benzene (ug/L)		Tetrachloroethene (ug/L)		bis(2-Ethylhexyl)phthalate (ug/L)		Arsenic (ug/L)		Cadmium (ug/L)		Copper (ug/L)	
CUL		1		71		8.8		2.2[a]		36		8		2.9	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max
AC-06A	early warning	<2	<2	-	-	-	-	-	-	0.2	0.6	0.008	0.241	0.1	0.66
HI-1	compliance	<2	<2	-	-	-	-	-	-	0.06	0.93	0.007	0.021	0.12	0.58
HI-2	compliance	<2	<2	-	-	-	-	-	-	0.17	1.36	0.008	0.028	0.071	0.607
HI-3	compliance	<2	***2***	-	-	-	-	-	-	0.05	1.3	0.408	1.53	0.152	1.13
HI-4	compliance	<2	<2	-	-	-	-	-	-	0.08	0.44	0.02	0.289	0.15	0.53
HI-5	compliance	0.85	***2***	-	-	-	-	0.15	<2	0.03	0.06	0.034	0.034	0.039	0.646
HI-6A	compliance	0.84	***3***	-	-	-	-	-	-	0.07	0.22	0.007	0.031	0.102	0.495
HI-7	boundary	<2	<2	-	-	0.12	1.9	-	-	0.37	3	0.026	***13.97***	1.14	***3.87***
HI-8	boundary	<2	<2	-	-	-	-	-	-	0.2	0.61	0.014	0.088	0.32	0.59
HI-9A	compliance	<2	***17***	-	-	-	-	-	-	0.06	4.04	0.005	0.1	0.066	0.53
HI-10	compliance	<2	<2	-	-	-	-	-	-	0.35	0.59	0.021	0.24	1.42	2.64
HI-11	compliance	<2	<2	-	-	-	-	-	-	0.12	0.26	0.004	0.025	0.15	0.86
HI-12	compliance	<2	<2	-	-	-	-	-	-	0.21	6.32	0.04	0.334	1.94	***6.95***
HI-13	early warning	<2	***7.4***	-	-	-	-	-	-	0.2	0.58	0.016	0.789	0.16	1.16
HI-14	early warning	<2	<2	-	-	-	-	-	-	0.1	0.26	0.018	0.935	0.1	0.215
HI-15	early warning	<2	***54***	-	-	-	-	-	-	0.2	3.1	0.009	0.143	0.14	1.66
HI-16	compliance	<2	<2	-	-	-	-	-	-	0.05	1.4	0.006	0.283	0.042	0.81
HI-17	interior	<2	<2	-	-	-	-	-	-	***116***	***637***	***18.7***	***881***	***5.43***	***598***
HI-18	interior	<2	***7***	-	-	-	-	-	-	2.65	4.41	0.007	0.176	0.23	0.78
MW-01	compliance	<2	***2***	-	-	-	-	-	-	0.9	5.76	0.02	0.049	0.32	***29.2***
MW-213	compliance	<2	<2	-	-	-	-	-	-	0.05	8.84	0.027	0.315	0.484	***63.2***
TD-06A	compliance	1	***6***	<0.05	<0.05	-	-	-	-	0.03	0.17	0.005	0.472	0.346	1.64

[a] Based on NRWQC Human Health consumption of organism

highlighted indicates exceendence of the CUL

Table B-1. S&G-OU1, Summary of Semi-Annual Sampling

Well	Location	Lead (ug/L)		Mercury (ng/L)		Nickel (ug/L)		Silver (ug/L)		Thallium (ug/L)		Zinc (ug/L)	
CUL		2.8		25		7.9		1.2		6.3		76.6	
		min	max	min	max	min	max	min	max	min	max	min	max
AC-06A	early warning	0.044	***1890***	0.08	1.66	0.17	2.26	<0.02	<0.04	<0.02	<0.04	0.36	7.6
HI-1	compliance	0.053	***24.1***	0.17	<1	0.27	0.62	0.01	0.036	0.008	<0.03	0.67	2.6
HI-2	compliance	0.057	***11.5***	0.18	<1	0.09	4.53	0.003	<0.02	0.007	0.02	0.6	1.78
HI-3	compliance	0.159	0.736	0.24	1.14	0.29	1.11	0.004	<0.02	0.074	0.074	2.58	25.3
HI-4	compliance	0.02	1.22	0.17	<1	0.07	1.88	0.004	<0.02	<0.02	<0.02	0.76	3.2
HI-5	compliance	0.018	0.151	0.5	1.53	0.55	1.12	<0.02	<0.20	0.08	0.08	0.1	1.22
HI-6A	compliance	0.024	0.226	0.07	3.24	0.1	0.42	0.002	<0.04	<0.02	<0.04	0.3	6.75
HI-7	boundary	0.041	1.44	1.49	6.29	0.9	4.03	0.006	<0.02	0.008	0.043	0.39	55.9
HI-8	boundary	0.036	***4.42***	0.1	<1	0.37	2.06	0.03	0.03	0.0011	0.025	0.7	2.17
HI-9A	compliance	<0.02	0.794	0.07	<1	<0.2	1.39	0.003	<0.1	<0.02	<0.04	0.1	2.8
HI-10	compliance	0.032	0.713	0.84	1.55	0.79	2.87	0.004	0.033	0.011	0.055	1.15	5.8
HI-11	compliance	0.05	***4.71***	0.3	1.21	0.13	1.67	<0.02	<0.02	0.003	<0.02	0.19	1.6
HI-12	compliance	0.23	***6.47***	1.3	12.3	0.92	5.77	0.006	0.046	0.012	0.025	2.8	***189***
HI-13	early warning	0.062	***3.18***	0.8	1.25	0.26	0.67	0.023	0.023	<0.02	<0.02	0.5	11.6
HI-14	early warning	0.04	1.03	0.48	2.9	0.2	2.85	0.003	<0.104	<0.02	<0.104	0.41	1.3
HI-15	early warning	0.038	1.67	0.12	<1	0.23	3.14	0.043	0.043	<0.02	<0.02	0.5	***86.1***
HI-16	compliance	0.091	***6.49***	0.1	<1	0.3	1.57	0.006	<0.04	<0.02	<0.04	0.18	3.9
HI-17	interior	***20.7***	***593***	1.04	7.41	***281***	***608***	0.004	<0.1	0.082	0.269	***269***	***3420***
HI-18	interior	0.026	***12.4***	0.31	1.05	1.38	3.75	<0.02	<0.1	<0.02	<0.02	0.6	2.6
MW-01	compliance	0.142	***10.1***	0.41	8.09	0.4	2.59	0.008	0.027	0.003	<0.02	0.5	52.5
MW-213	compliance	0.157	***15.1***	0.57	***48.5***	0.22	6.86	0.008	0.126	0.007	0.064	1.5	***135***
TD-06A	compliance	0.05	1.01	0.23	0.35	0.16	0.65	0.004	<0.02	0.006	<0.02	2.1	17.5

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	HI-1	HI-2	HI-3	HI-4	HI-5	HI-6	HI-6A	HI-7	HI-8	HI-9	HI-9A	HI-9A
			Sample ID	HI-1-1114	HI-2-1114	HI-3-1114	HI-4-1114	HI-5-1114	HI-6-1114	HI-6A-1114	HI-7-1114	HI-8-1114	HI-9-1114	HI-90A-1114	HI-9A-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/5/2014	11/4/2014	11/5/2014	11/5/2014	11/5/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014
			Sample Type	N	N	N	N	N	N	N	N	N	N	FD	N
			Parent Sample ID											HI-9A-1114	
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
Cyanide															
Available Cyanide	µg/l	1	1	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	**33**	**26**
Metals (total)															
Antimony	µg/l	640		< 0.05	< 1	< 1	**0.061** J+	< 1	NA	< 1	NA	NA	NA	< 0.05	< 0.05
Arsenic	µg/l	0.14	36	**0.4**	**0.3**	**0.1**	**0.2**	< 0.5	**0.2**	**0.1**	**3**	**0.2**	**0.9**	**0.3**	**0.4**
Cadmium	µg/l	8.8	8	< 0.02	< 0.02	**0.44**	**0.056**	< 0.02	< 0.02	< 0.02	**0.171**	**0.038**	**0.029**	< 0.02	**0.005**
Chromium	µg/l			**0.65** J+	**0.92** J+	**0.53** J+	**0.66** J	< 0.2	NA	< 0.2	NA	NA	NA	**0.57** J+	**0.76** J+
Copper	µg/l	3.1	2.9	**0.17** J+	**0.24**	**0.34**	**0.2**	< 0.1	**0.64**	< 0.1	**2.45**	**0.35**	**1.65**	**0.15** J+	**0.27**
Lead	µg/l	8.1	5.8	**0.341**	**0.102**	**0.565**	**0.523**	< 0.02	**0.129**	**0.028** J+	**0.426**	< 0.02	< 0.02	**0.056** J	**0.172** J
Mercury	µg/l	0.94	0.025	**0.00017**	**0.00018**	**0.00024**	**0.00044**	**0.0005**	**0.00504**	**0.00007**	**0.006**	**0.0001**	**0.00075**	**0.00007**	**0.00023**
Nickel	µg/l	8.2	7.9	**0.35** J+	< 0.2	< 0.2	**0.44** J+	< 0.8	< 0.2	< 0.2	**1.21** J+	**0.99** J+	**1.15** J+	**0.67** J+	**0.73** J+
Silver	µg/l	1.9	1.2	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Thallium	µg/l	0.47	6.3	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	**0.011**	< 0.02	< 0.02
Zinc	µg/l	81	76.6	**0.9** J+	**1.7** J+	**4.9**	**1.1** J+	< 0.5	**1.8** J+	< 0.5	**1.5** J+	**1.1** J+	< 0.5	**2.8** J	**0.8** J
Polychlorinated biphenyl															
Aroclor 1016	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021 J	< 0.021 J	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021 J	< 0.02	< 0.021
Aroclor 1221	µg/l	0.03	0.03	< 0.041	< 0.04	< 0.041 J	< 0.041 J	< 0.04	< 0.04	< 0.04	< 0.04	< 0.043	< 0.041	< 0.04	< 0.041
Aroclor 1232	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021 J	< 0.021 J	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021 J	< 0.02	< 0.021
Aroclor 1242	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021 J	< 0.021 J	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021 J	< 0.02	< 0.021
Aroclor 1248	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021 J	< 0.021 J	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021 J	< 0.02	< 0.021
Aroclor 1254	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021	< 0.021	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< *0.038* J	< 0.02	< 0.021
Aroclor 1260	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021	< 0.021	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021	< 0.02	< 0.021
Aroclor 1262	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021	< 0.021	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021	< 0.02	< 0.021
Aroclor 1268	µg/l	0.03	0.03	< 0.021	< 0.02	< 0.021	< 0.021	< 0.02	< 0.02	< 0.02	< 0.02	< 0.022	< 0.021	< 0.02	< 0.021
Volatile Organic Compounds															
1,1,1,2-TETRACHLORROETHANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,1,1-Trichloroethane	µg/l	200 (MTCA A)	42	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2,2-TETRACHLOROETHANE	µg/l	4		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,1,2-TRICHLOROETHANE	µg/l	16	42	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1-DICHLOROETHANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,1-DICHLOROETHYLENE	µg/l	7100		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,1-Dichloropropene	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,2,3-Trichlorobenzene	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
1,2,3-Trichloropropane	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,2,4-Trichlorobenzene	µg/l	70		< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
1,2,4-TRIMETHYLBENZENE	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
1,2-Dibromoethane	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
1,2-Dichlorobenzene	µg/l	1300		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,2-DICHLOROETHANE	µg/l	37		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,2-Dichloropropane	µg/l	15		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,3,5-Trimethylbenzene	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
1,3-DICHLOROPROPANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
1,4-Dichlorobenzene	µg/l	190		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
2,2-Dichloropropane	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
2-Butanone	µg/l			< 20	< 20	< 20	< 20	< 20	NA	< 20	NA	NA	NA	< 20	< 20
2-CHLOROTOLUENE	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
2-PHENYLBUTANE	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
4-CHLOROTOLUENE	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
4-Methyl-2-Pentanone (MIBK)	µg/l			< 20	< 20	< 20	< 20	< 20	NA	< 20	NA	NA	NA	< 20	< 20
ACETONE	µg/l			< 20	< 20	< 20	< 20	< 20	NA	< 20	NA	NA	NA	< 20	< 20
Benzene	µg/l	51	71	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)	HI-1	HI-2	HI-3	HI-4	HI-5	HI-6	HI-6A	HI-7	HI-8	HI-9	HI-9A	HI-9A
			Sample ID	HI-1-1114	HI-2-1114	HI-3-1114	HI-4-1114	HI-5-1114	HI-6-1114	HI-6A-1114	HI-7-1114	HI-8-1114	HI-9-1114	HI-90A-1114	HI-9A-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/5/2014	11/4/2014	11/5/2014	11/5/2014	11/5/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014
			Sample Type	N	N	N	N	N	N	N	N	N	N	FD	N
			Parent Sample ID											HI-9A-1114	
BROMOBENZENE	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
BROMODICHLOROMETHANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
BROMOMETHANE	µg/l			< 0.5 J	< 0.5 J	< 0.5 J	< 0.5 J	< 0.5 J	NA	< 0.5 J	NA	NA	NA	< 0.5 J	< 0.5 J
CARBON DISULFIDE	µg/l			< 0.5	< 0.5	< 0.5 U	< 0.5 U	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CARBON TETRACHLORIDE	µg/l	1.6	4.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
CFC-11	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CFC-12	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CHLOROBENZENE	µg/l	1600		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CHLOROBROMOMETHANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CHLORODIBROMOMETHANE	µg/l	17		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CHLOROETHANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CHLOROFORM	µg/l	470		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CHLOROMETHANE	µg/l			< 0.5 J	< 0.5 J	**0.18 J**	< 0.5 J	**0.1 J**	NA	< 0.5 J	NA	NA	NA	< 0.5 J	< 0.5 J
cis-1,2-Dichloroethene	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	**0.7**	**0.79**
cis-1,3-Dichloropropene	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
CYMENE	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
DIBROMOMETHANE	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
DICHLOROMETHANE	µg/l	590		< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
ETHYLBENZENE	µg/l	2100		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
Hexachlorobutadiene	µg/l	18		< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
Isopropylbenzene	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
m,p-Xylene	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
M-Dichlorobenzene	µg/l	960		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
METHYL N-BUTYL KETONE	µg/l			< 20	< 20	< 20	< 20	< 20	NA	< 20	NA	NA	NA	< 20	< 20
m-Xylene & p-Xylene	µg/l			< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	NA	< 0.11	NA	NA	NA	< 0.11	< 0.11
Naphthalene	µg/l			< 2	< 2	< 2 J	< 2 J	< 2	NA	< 2 J	NA	NA	NA	< 2	< 2
n-Butylbenzene	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
n-Propylbenzene	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
o-Xylene	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
STYRENE (MONOMER)	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
tert-Butylbenzene	µg/l			< 2	< 2	< 2	< 2	< 2	NA	< 2	NA	NA	NA	< 2	< 2
Tetrachloroethene	µg/l	3.3	8.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**0.59**	< 0.5	< 0.5	< 0.5	< 0.5
Toluene	µg/l	15000		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
trans-1,2-Dichloroethene	µg/l	10000		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
trans-1,3-Dichloropropene	µg/l			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
TRIBOMOMETHANE	µg/l	140		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
TRICHLOROETHYLENE	µg/l	30		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
Vinyl Chloride	µg/l	150		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	**0.2**	**0.23**
Semi-volatile Organic Compounds															
1,2,4-Trichlorobenzene	µg/l			< 0.19 J	< 0.19 J	< 0.19 J	< 0.19	< 0.19 J	NA	< 0.2 J	NA	NA	NA	< 0.2 J	< 0.2 J
1,2-Dichlorobenzene	µg/l	1300		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
1,4-Dichlorobenzene	µg/l	190		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
2,4,5-TRICHLOROPHENOL	µg/l	3600		< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
2,4,6-Trichlorophenol	µg/l			< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
2,4-DICHLOROPHENOL	µg/l	290		< 0.48 J	< 0.48 J	< 0.48 J	< 0.48	< 0.48 J	NA	< 0.5 J	NA	NA	NA	< 0.5 J	< 0.5 J
2,4-Dimethyl Phenol	µg/l	850		< 3.8	< 3.8	< 3.8	< 3.8	< 3.8	NA	< 4	NA	NA	NA	< 4	< 4
2,4-DINITROPHENOL	µg/l	5300		< 3.8 J	< 3.8 J	< 3.8 J	< 3.8	< 3.8 J	NA	< 4 J	NA	NA	NA	< 4 J	< 4 J
2,4-DINITROTOLUENE	µg/l	3.4		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
2,6-DINITROTOLUENE	µg/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
2-Chlornaphthalene	µg/l	1600		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
2-CHLOROPHENOL	µg/l	150		< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
2-Methylnaphthalene	µg/l			< 0.19 J	< 0.19 J	< 0.19 J	< 0.19	< 0.19 J	NA	< 0.2 J	NA	NA	NA	< 0.2 J	< 0.2 J

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	HI-1	HI-2	HI-3	HI-4	HI-5	HI-6	HI-6A	HI-7	HI-8	HI-9	HI-9A	HI-9A
			Sample ID	HI-1-1114	HI-2-1114	HI-3-1114	HI-4-1114	HI-5-1114	HI-6-1114	HI-6A-1114	HI-7-1114	HI-8-1114	HI-9-1114	HI-90A-1114	HI-9A-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/5/2014	11/4/2014	11/5/2014	11/5/2014	11/5/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014
			Sample Type	N	N	N	N	N	N	N	N	N	N	FD	N
			Parent Sample ID											HI-9A-1114	
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
2-Methylphenol	µg/l			< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
2-NITROANILINE	µg/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
2-NITROPHENOL	µg/l			< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
3,3'-DICHLOROBENZIDINE	µg/l			< 1.9 R	< 1.9 R	< 1.9 R	< 1.9 R	< 1.9 R	NA	< 2 R	NA	NA	NA	< 2 R	< 2 R
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	µg/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
3-NITROANILINE	µg/l			< 0.95	< 0.95	< 0.95	< 0.95	< 0.95	NA	< 0.99	NA	NA	NA	< 1	< 1
4,6-Dinitro-2-Methylphenol	µg/l	280		< 1.9	< 1.9	< 1.9	< 1.9	< 1.9	NA	< 2	NA	NA	NA	< 2	< 2
4-BROMOPHENYL PHENYL ETHER	µg/l			< 0.19 J	< 0.19 J	< 0.19 J	< 0.19	< 0.19 J	NA	< 0.2 J	NA	NA	NA	< 0.2 J	< 0.2 J
4-Chloro-3-methylphenol	µg/l			< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
4-CHLOROPHENYL PHENYL ETHER	µg/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
4-Methylphenol	µg/l			< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
4-NITROPHENOL	µg/l			< 1.9 J	< 1.9 J	< 1.9 J	< 1.9 J	< 1.9 J	NA	< 2 J	NA	NA	NA	< 2 J	< 2 J
Acenaphthene	µg/l	990		< 0.19	< 0.19	< 0.19	< 0.19	**0.37**	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Acenaphthylene	µg/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
ANTHRACENE	µg/l	40000		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	**0.028**	**0.024**
Benzo (a) anthracene	µg/l	0.018		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Benzo (a) pyrene	µg/l	0.018		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Benzo (b) fluoranthene	µg/l	0.018		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Benzo (ghi) perylene	µg/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Benzo (k) fluoranthene	ug/l	0.018		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
BENZOIC ACID	ug/l			< 4.8 UJ	< 4.8 UJ	< 4.8 J	< 4.8 UJ	< 4.8 UJ	NA	< 5 UJ	NA	NA	NA	< 5 UJ	< 5 UJ
BENZYL ALCOHOL	ug/l			< 0.48	< 0.48	< 0.48	< 0.48 J	**0.082**	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
bis(2-Chloroethoxy) Methane	ug/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Bis-(2-Chloroethyl) Ether	ug/l	0.53		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Bis(2-chloroisopropyl)ether	ug/l			< 0.19 J	< 0.19 J	< 0.19 J	< 0.19	< 0.19 J	NA	< 0.2 J	NA	NA	NA	< 0.2 J	< 0.2 J
bis(2-Ethylhexyl)phthalate	ug/l	2.2		< 0.95	< 0.95	< 0.95	< 0.95	< 0.95	NA	< 0.99	NA	NA	NA	< 1	< 1
Butyl Benzyl Phthalate	ug/l	1900		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Chrysene	ug/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Dibenz (a,h) anthracene	ug/l	0.018		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
DIBENZOFURAN	ug/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Diethyl Phthalate	ug/l	44000		< 0.19	< 0.19	< 0.19	< 0.19 J	< 0.19	NA	**0.023**	NA	NA	NA	< 0.2	< 0.2
Dimethyl Phthalate	ug/l	1100000		< 0.19	< 0.19	**0.36**	**0.3**	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Di-n-Butylphthalate	ug/l	4500		< 0.19	< 0.19	< 0.19	< 0.19 J	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Di-n-Octyl phthalate	ug/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
FLUORANTHENE	ug/l	140		< 0.19	< 0.19	< 0.19	< 0.19 J	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
FLUORENE	ug/l	5300		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
HEXACHLOROBENZENE	ug/l	0.00029		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Hexachlorobutadiene	ug/l	18		< 0.19 J	< 0.19 J	< 0.19 J	< 0.19	< 0.19 J	NA	< 0.2 J	NA	NA	NA	< 0.2 J	< 0.2 J
HEXACHLOROCYCLOPENTADIENE	ug/l	1000		< 0.95 R	< 0.95 R	< 0.95 R	< 0.95 R	< 0.95 R	NA	< 0.99 R	NA	NA	NA	< 1 R	< 1 R
HEXACHLOROETHANE	ug/l	3.3		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
Indeno (1,2,3-cd) pyrene	ug/l	0.018		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
M-Dichlorobenzene	ug/l	960		**0.027**	**0.05**	< 0.19	< 0.19	**0.044**	NA	< 0.2	NA	NA	NA	**0.039**	**0.057**
Naphthalene	ug/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
NITROBENZENE	ug/l	690		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
N-Nitroso-Di-N-Propylamine	ug/l	0.51		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
N-NITROSODIPHENYLAMINE	ug/l	6		< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
P-CHLOROANILINE	ug/l			< 0.19 R	< 0.19 R	< 0.19 R	**0.12 J**	< 0.19 R	NA	< 0.2 R	NA	NA	NA	< 0.2 R	< 0.2 R
PENTACHLOROPHENOL	ug/l	3		< 0.95	< 0.95	< 0.95	< 0.95	< 0.95	NA	< 0.99	NA	NA	NA	< 1	< 1
PHENANTHRENE	ug/l			< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2
PHENOL	ug/l	1700000		< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	NA	< 0.5	NA	NA	NA	< 0.5	< 0.5
P-NITROANILINE	ug/l			< 0.95	< 0.95	< 0.95	< 0.95	< 0.95	NA	< 0.99	NA	NA	NA	< 1	< 1
PYRENE	ug/l	4000		< 0.19	< 0.19	< 0.19	< 0.19 J	< 0.19	NA	< 0.2	NA	NA	NA	< 0.2	< 0.2

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	HI-1	HI-2	HI-3	HI-4	HI-5	HI-6	HI-6A	HI-7	HI-8	HI-9	HI-9A	HI-9A
			Sample ID	HI-1-1114	HI-2-1114	HI-3-1114	HI-4-1114	HI-5-1114	HI-6-1114	HI-6A-1114	HI-7-1114	HI-8-1114	HI-9-1114	HI-90A-1114	HI-9A-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/5/2014	11/4/2014	11/5/2014	11/5/2014	11/5/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014
			Sample Type	N	N	N	N	N	N	N	N	N	N	FD	N
			Parent Sample ID											HI-9A-1114	
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
Semi-volatile Organic Compounds (SIM)															
2-Methylnaphthalene	ug/l			< 0.019	< 0.019	< 0.024	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Acenaphthene	ug/l			< 0.019	< 0.019	< 0.029	< 0.019	**0.3**	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Acenaphthylene	ug/l			< 0.019	< 0.019	< 0.019	< 0.023	**0.006**	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
ANTHRACENE	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Benzo (a) anthracene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Benzo (a) pyrene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Benzo (b) fluoranthene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Benzo (ghi) perylene	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Benzo (k) fluoranthene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Chrysene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Dibenz (a,h) anthracene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
DIBENZOFURAN	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
FLUORANTHENE	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
FLUORENE	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	**0.008**	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Indeno (1,2,3-cd) pyrene	ug/l	.018		< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
Naphthalene	ug/l			< 0.056	< 0.019	< 0.056	< 0.056	< 0.056	NA	< 0.019	NA	NA	NA	< 0.02	< 0.056
PHENANTHRENE	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02
PYRENE	ug/l			< 0.019	< 0.019	< 0.019	< 0.019	< 0.019	NA	< 0.019	NA	NA	NA	< 0.02	< 0.02

Notes:

Bold = detected concentration

ROD CUG = Record of Decision cleanup goal

NRWQC - National Recommended Water Quality Criteria (Lower of acute or chronic saltwater criteria or Human Health for the consumption of organism only)

Sample Type Key:

N = Normal Sample

FD = Field Duplicate

Qualifier Key:

R = Rejected Concentration

J = Estimated Concentration

J+ = Estimated Concentration, biased high

< 0.3 = Concentration not detected above the method reporting limit

NA = Not Analyzed

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	HI-10	HI-10A	HI-11	HI-12	HI-12A	HI-13	HI-14	HI-15	HI-16	HI-17	HI-17	HI-18
			Sample ID	HI-10-1114	HI-10A-1114	HI-11-1114	HI-12-1114	HI-12A-1114	HI-13-1114	HI-14-1114	HI-15-1114	HI-16-1114	HI-170-1114	HI-17-1114	HI-18-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/6/2014	11/6/2014	11/6/2014
			Sample Type	N	N	N	N	N	N	N	N		FD	N	N
			Parent Sample ID										HI-17-1114		
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
Cyanide															
Available Cyanide	µg/l	1	1	< 2	< 2	< 2	< 2	< 2	7.4	< 2	54	< 2	< 2	< 2	< 2
Metals (total)															
Antimony	µg/l	640		NA	< 1	0.377	NA	< 1	NA	NA	NA	0.099 J+	NA	NA	NA
Arsenic	µg/l	0.14	36	0.4	0.1	< 0.5 J	0.3	0.2	0.2 J-	0.2	1.8	0.4 J-	636	637	3.5
Cadmium	µg/l	8.8	8	0.221	< 0.02	0.018	0.097	< 0.02	0.017	< 0.02	0.009	0.006	51.6	52.4	0.009
Chromium	µg/l			NA	< 0.2	0.97 J+	NA	0.36 J+	NA	NA	NA	0.84 J+	NA	NA	NA
Copper	µg/l	3.1	2.9	1.54	< 0.1	0.86	3.71	< 0.1	0.16 J+	0.1 J+	0.38	0.19 J+	19.2	20	0.23
Lead	µg/l	8.1	5.8	< 0.02	0.751	0.105	0.598	< 0.02	0.244	0.057 J+	0.064 J+	0.501	66	66.4	0.052 J+
Mercury	µg/l	0.94	0.025	0.00084	< 0.0005	0.00077	0.00324	0.00021	0.0008	0.00048	0.00012	0.0001	0.00104	0.00111	0.00031
Nickel	µg/l	8.2	7.9	2.48 J+	0.56 J+	1.51 J+	2.21 J+	< 0.2	0.33 J+	0.2 J+	1.1 J+	0.87 J+	453	464	1.38 J+
Silver	µg/l	1.9	1.2	0.033 J+	< 0.02	< 0.02	0.028 J+	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Thallium	µg/l	0.47	6.3	0.048	< 0.02	< 0.02	0.024	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.084 J+	0.082 J+	< 0.02
Zinc	µg/l	81	76.6	5.8	2.3 J+	0.6 J+	42.5	3.2 J+	1 J+	< 0.5	86.1	< 0.5	799	810	0.6 J+
Polychlorinated biphenyl															
Aroclor 1016	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02 J	0.006 J	< 0.021 J	< 0.021 J	< 0.021	< 0.02	< 0.021
Aroclor 1221	µg/l	0.03	0.03	< 0.041	< 0.041	< 0.043	< 0.041	< 0.041	< 0.04 J	< 0.04 J	< 0.041 J	< 0.041	< 0.041	< 0.04	< 0.041
Aroclor 1232	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.021	< 0.02	< 0.021
Aroclor 1242	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.021	< 0.02	< 0.021
Aroclor 1248	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.021	< 0.02	< 0.021
Aroclor 1254	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02	< 0.02 J	< 0.021 J	< 0.021	< 0.021	< 0.02	< 0.021
Aroclor 1260	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02	0.0074 J	< 0.021 J	< 0.021	< 0.021	< 0.02	< 0.021
Aroclor 1262	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02	< 0.02 J	< 0.021 J	< 0.021	< 0.021	< 0.02	< 0.021
Aroclor 1268	µg/l	0.03	0.03	< 0.021	< 0.021	< 0.022	< 0.021	< 0.021	< 0.02	< 0.02 J	< 0.021 J	< 0.021	< 0.021	< 0.02	< 0.021
Volatile Organic Compounds															
1,1,1,2-TETRACHLORROETHANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,1,1-Trichloroethane	µg/l	200 (MTCA A)	42	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2,2-TETRACHLOROETHANE	µg/l	4		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,1,2-TRICHLOROETHANE	µg/l	16	42	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1-DICHLOROETHANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,1-DICHLOROETHYLENE	µg/l	7100		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,1-Dichloropropene	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,2,3-Trichlorobenzene	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
1,2,3-Trichloropropane	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,2,4-Trichlorobenzene	µg/l	70		NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
1,2-Dibromoethane	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
1,2-Dichlorobenzene	µg/l	1300		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,2-DICHLOROETHANE	µg/l	37		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,2-Dichloropropane	µg/l	15		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,3,5-Trimethylbenzene	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
1,3-DICHLOROPROPANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
1,4-Dichlorobenzene	µg/l	190		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
2,2-Dichloropropane	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
2-Butanone	µg/l			NA	< 20	< 20	NA	< 20	NA	NA	NA	< 20	NA	NA	NA
2-CHLOROTOLUENE	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
2-PHENYLBUTANE	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
4-CHLOROTOLUENE	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
4-Methyl-2-Pentanone (MIBK)	µg/l			NA	< 20	< 20	NA	< 20	NA	NA	NA	< 20	NA	NA	NA
ACETONE	µg/l			NA	< 20	< 20	NA	< 20	NA	NA	NA	< 20	NA	NA	NA
Benzene	µg/l	51	71	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	**HI-10**	**HI-10A**	**HI-11**	**HI-12**	**HI-12A**	**HI-13**	**HI-14**	**HI-15**	**HI-16**	**HI-17**	**HI-17**	**HI-18**
			Sample ID	**HI-10-1114**	**HI-10A-1114**	**HI-11-1114**	**HI-12-1114**	**HI-12A-1114**	**HI-13-1114**	**HI-14-1114**	**HI-15-1114**	**HI-16-1114**	**HI-170-1114**	**HI-17-1114**	**HI-18-1114**
			Sample Date	**11/4/2014**	**11/4/2014**	**11/5/2014**	**11/4/2014**	**11/4/2014**	**11/4/2014**	**11/4/2014**	**11/4/2014**	**11/4/2014**	**11/6/2014**	**11/6/2014**	**11/6/2014**
			Sample Type	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**		**FD**	**N**	**N**
			Parent Sample ID										**HI-17-1114**		
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
BROMOBENZENE	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
BROMODICHLOROMETHANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
BROMOMETHANE	µg/l			NA	< 0.5 J	< 0.5 J	NA	< 0.5 J	NA	NA	NA	< 0.5 J	NA	NA	NA
CARBON DISULFIDE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CARBON TETRACHLORIDE	µg/l	1.6	4.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
CFC-11	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CFC-12	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CHLOROBENZENE	µg/l	1600		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CHLOROBROMOMETHANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CHLORODIBROMOMETHANE	µg/l	17		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CHLOROETHANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CHLOROFORM	µg/l	470		NA	< 0.5	**2.7**	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CHLOROMETHANE	µg/l			NA	< 0.5 J	< 0.5 J	NA	**0.13 J**	NA	NA	NA	< 0.5 J	NA	NA	NA
cis-1,2-Dichloroethene	µg/l			NA	< 0.5	< 0.5	NA	**0.21**	NA	NA	NA	< 0.5	NA	NA	NA
cis-1,3-Dichloropropene	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
CYMENE	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
DIBROMOMETHANE	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
DICHLOROMETHANE	µg/l	590		NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
ETHYLBENZENE	µg/l	2100		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
Hexachlorobutadiene	µg/l	18		NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
Isopropylbenzene	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
m,p-Xylene	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5 U	NA	NA	NA
M-Dichlorobenzene	µg/l	960		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
METHYL N-BUTYL KETONE	µg/l			NA	< 20	< 20	NA	< 20	NA	NA	NA	< 20	NA	NA	NA
m-Xylene & p-Xylene	µg/l			NA	< 0.11	< 0.11	NA	< 0.11	NA	NA	NA	**0.45**	NA	NA	NA
Naphthalene	µg/l			NA	< 2	< 2 J	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
n-Butylbenzene	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
n-Propylbenzene	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
o-Xylene	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	**0.13**	NA	NA	NA
STYRENE (MONOMER)	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
tert-Butylbenzene	µg/l			NA	< 2	< 2	NA	< 2	NA	NA	NA	< 2	NA	NA	NA
Tetrachloroethene	µg/l	3.3	8.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Toluene	µg/l	15000		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5 U	NA	NA	NA
trans-1,2-Dichloroethene	µg/l	10000		NA	< 0.5	< 0.5	NA	**0.14**	NA	NA	NA	< 0.5	NA	NA	NA
trans-1,3-Dichloropropene	µg/l			NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
TRIBOMOMETHANE	µg/l	140		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
TRICHLOROETHYLENE	µg/l	30		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
Vinyl Chloride	µg/l	150		NA	< 0.5	< 0.5	NA	< 0.5	NA	NA	NA	< 0.5	NA	NA	NA
Semi-volatile Organic Compounds															
1,2,4-Trichlorobenzene	µg/l			NA	< 0.19 J	< 0.21 J	NA	< 0.19 J	NA	NA	NA	< 0.2 J	NA	NA	NA
1,2-Dichlorobenzene	µg/l	1300		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
1,4-Dichlorobenzene	µg/l	190		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
2,4,5-TRICHLOROPHENOL	µg/l	3600		NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
2,4,6-Trichlorophenol	µg/l			NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
2,4-DICHLOROPHENOL	µg/l	290		NA	< 0.48 J	< 0.52 J	NA	< 0.48 J	NA	NA	NA	< 0.5 J	NA	NA	NA
2,4-Dimethyl Phenol	µg/l	850		NA	< 3.8	< 4.1	NA	< 3.8	NA	NA	NA	< 4	NA	NA	NA
2,4-DINITROPHENOL	µg/l	5300		NA	< 3.8 J	< 4.1 J	NA	< 3.8 J	NA	NA	NA	< 4 J	NA	NA	NA
2,4-DINITROTOLUENE	µg/l	3.4		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
2,6-DINITROTOLUENE	µg/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
2-Chlornaphthalene	µg/l	1600		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
2-CHLOROPHENOL	µg/l	150		NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
2-Methylnaphthalene	µg/l			NA	< 0.19 J	< 0.21 J	NA	< 0.19 J	NA	NA	NA	< 0.2 J	NA	NA	NA

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	HI-10	HI-10A	HI-11	HI-12	HI-12A	HI-13	HI-14	HI-15	HI-16	HI-17	HI-17	HI-18
			Sample ID	HI-10-1114	HI-10A-1114	HI-11-1114	HI-12-1114	HI-12A-1114	HI-13-1114	HI-14-1114	HI-15-1114	HI-16-1114	HI-170-1114	HI-17-1114	HI-18-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/6/2014	11/6/2014	11/6/2014
			Sample Type	N	N	N	N	N	N	N	N		FD	N	N
			Parent Sample ID										HI-17-1114		
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
2-Methylphenol	µg/l			NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
2-NITROANILINE	µg/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
2-NITROPHENOL	µg/l			NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
3,3'-DICHLOROBENZIDINE	µg/l			NA	< 1.9 R	< 2.1 R	NA	< 1.9 R	NA	NA	NA	< 2 R	NA	NA	NA
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	µg/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
3-NITROANILINE	µg/l			NA	< 0.95	< 1.1	NA	< 0.95	NA	NA	NA	< 0.99	NA	NA	NA
4,6-Dinitro-2-Methylphenol	µg/l	280		NA	< 1.9	< 2.1	NA	< 1.9	NA	NA	NA	< 2	NA	NA	NA
4-BROMOPHENYL PHENYL ETHER	µg/l			NA	< 0.19 J	< 0.21 J	NA	< 0.19 J	NA	NA	NA	< 0.2 J	NA	NA	NA
4-Chloro-3-methylphenol	µg/l			NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
4-CHLOROPHENYL PHENYL ETHER	µg/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
4-Methylphenol	µg/l			NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
4-NITROPHENOL	µg/l			NA	< 1.9 J	< 2.1 J	NA	< 1.9 J	NA	NA	NA	< 2 J	NA	NA	NA
Acenaphthene	µg/l	990		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Acenaphthylene	µg/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
ANTHRACENE	µg/l	40000		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Benzo (a) anthracene	µg/l	0.018		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Benzo (a) pyrene	µg/l	0.018		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Benzo (b) fluoranthene	µg/l	0.018		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Benzo (ghi) perylene	µg/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Benzo (k) fluoranthene	ug/l	0.018		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
BENZOIC ACID	ug/l			NA	< 4.8 UJ	< 5.2 J	NA	< 4.8 UJ	NA	NA	NA	< 5 UJ	NA	NA	NA
BENZYL ALCOHOL	ug/l			NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
bis(2-Chloroethoxy) Methane	ug/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Bis-(2-Chloroethyl) Ether	ug/l	0.53		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Bis(2-chloroisopropyl)ether	ug/l			NA	< 0.19 J	< 0.21 J	NA	< 0.19 J	NA	NA	NA	< 0.2 J	NA	NA	NA
bis(2-Ethylhexyl)phthalate	ug/l	2.2		NA	< 0.95	< 1.1	NA	< 0.95	NA	NA	NA	**1.4**	NA	NA	NA
Butyl Benzyl Phthalate	ug/l	1900		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Chrysene	ug/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Dibenz (a,h) anthracene	ug/l	0.018		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
DIBENZOFURAN	ug/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Diethyl Phthalate	ug/l	44000		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Dimethyl Phthalate	ug/l	1100000		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Di-n-Butylphthalate	ug/l	4500		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Di-n-Octyl phthalate	ug/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
FLUORANTHENE	ug/l	140		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
FLUORENE	ug/l	5300		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
HEXACHLOROBENZENE	ug/l	0.00029		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Hexachlorobutadiene	ug/l	18		NA	< 0.19 J	< 0.21 J	NA	< 0.19 J	NA	NA	NA	< 0.2 J	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	ug/l	1000		NA	< 0.95 R	< 1.1 R	NA	< 0.95 R	NA	NA	NA	< 0.99 R	NA	NA	NA
HEXACHLOROETHANE	ug/l	3.3		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
Indeno (1,2,3-cd) pyrene	ug/l	0.018		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
M-Dichlorobenzene	ug/l	960		NA	**0.022**	**0.036**	NA	**0.049**	NA	NA	NA	**0.046**	NA	NA	NA
Naphthalene	ug/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
NITROBENZENE	ug/l	690		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
N-Nitroso-Di-N-Propylamine	ug/l	0.51		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
N-NITROSODIPHENYLAMINE	ug/l	6		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
P-CHLOROANILINE	ug/l			NA	< 0.19 R	< 0.21 R	NA	< 0.19 R	NA	NA	NA	< 0.2 R	NA	NA	NA
PENTACHLOROPHENOL	ug/l	3		NA	< 0.95	< 1.1	NA	< 0.95	NA	NA	NA	< 0.99	NA	NA	NA
PHENANTHRENE	ug/l			NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA
PHENOL	ug/l	1700000		NA	< 0.48	< 0.52	NA	< 0.48	NA	NA	NA	< 0.5	NA	NA	NA
P-NITROANILINE	ug/l			NA	< 0.95	< 1.1	NA	< 0.95	NA	NA	NA	< 0.99	NA	NA	NA
PYRENE	ug/l	4000		NA	< 0.19	< 0.21	NA	< 0.19	NA	NA	NA	< 0.2	NA	NA	NA

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	HI-10	HI-10A	HI-11	HI-12	HI-12A	HI-13	HI-14	HI-15	HI-16	HI-17	HI-17	HI-18
			Sample ID	HI-10-1114	HI-10A-1114	HI-11-1114	HI-12-1114	HI-12A-1114	HI-13-1114	HI-14-1114	HI-15-1114	HI-16-1114	HI-170-1114	HI-17-1114	HI-18-1114
			Sample Date	11/4/2014	11/4/2014	11/5/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/4/2014	11/6/2014	11/6/2014	11/6/2014
			Sample Type	N	N	N	N	N	N	N	N		FD	N	N
			Parent Sample ID										HI-17-1114		
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)												
Semi-volatile Organic Compounds (SIM)															
2-Methylnaphthalene	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Acenaphthene	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	**0.012 J**	NA	NA	NA
Acenaphthylene	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
ANTHRACENE	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 UJ	NA	NA	NA
Benzo (a) anthracene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Benzo (a) pyrene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Benzo (b) fluoranthene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Benzo (ghi) perylene	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Benzo (k) fluoranthene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Chrysene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Dibenz (a,h) anthracene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
DIBENZOFURAN	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
FLUORANTHENE	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
FLUORENE	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Indeno (1,2,3-cd) pyrene	ug/l	.018		NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
Naphthalene	ug/l			NA	< 0.02	< 0.02	NA	< 0.056	NA	NA	NA	< 0.019 UJ	NA	NA	NA
PHENANTHRENE	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA
PYRENE	ug/l			NA	< 0.02	< 0.02	NA	< 0.019	NA	NA	NA	< 0.019 J	NA	NA	NA

Notes:

Bold = detected concentration

ROD CUG = Record of Decision cleanup goal

NRWQC - National Recommended Water Quality Criteria (Lower of acute or chronic saltwater criteria or Human Health

Sample Type Key:

N = Normal Sample

FD = Field Duplicate

Qualifier Key:

R = Rejected Concentration

J = Estimated Concentration

J+ = Estimated Concentration, biased high

< 0.3 = Concentration not detected above the method reporting limit

NA = Not Analyzed

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

				Location	AC-06A	AC-06A	MW-01	MW-213	TD-06A
				Sample ID	**AC-060A-1114**	**AC-06A-1114**	**MW-01-1114**	**MW-213-1114**	**TD-06A-1114**
				Sample Date	**11/5/2014**	**11/5/2014**	**11/5/2014**	**11/5/2014**	**11/5/2014**
				Sample Type	**FD**	**N**	**N**	**N**	**N**
				Parent Sample ID	**AC-06A-1114**				
	Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)					
Cyanide									
	Available Cyanide	µg/l	1	1	< 2	< 2	< 2	< 2	< 2
Metals (total)									
	Antimony	µg/l	640		NA	NA	< 0.05	< 1	< 1
	Arsenic	µg/l	0.14	36	< 0.5 J	< 0.5 J	**4.1**	**0.05**	**0.04**
	Cadmium	µg/l	8.8	8	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	Chromium	µg/l			NA	NA	**0.23** J+	< 0.2	**0.6** J+
	Copper	µg/l	3.1	2.9	**0.1** J+	< 0.1	**0.32**	**0.56**	**1.47**
	Lead	µg/l	8.1	5.8	**0.341**	**0.307**	**0.227**	**0.157**	**0.334**
	Mercury	µg/l	0.94	0.025	**0.00008**	< 0.0005	**0.00044**	**0.00057**	< 0.0005
	Nickel	µg/l	8.2	7.9	**0.39** J+	**0.41** J+	**1.04** J+	< 0.2	< 0.2
	Silver	µg/l	1.9	1.2	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	Thallium	µg/l	0.47	6.3	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	Zinc	µg/l	81	76.6	< 0.5	< 0.5	**0.5** J+	**1.5** J+	**8.2**
Polychlorinated biphenyl									
	Aroclor 1016	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1221	µg/l	0.03	0.03	< 0.04 J	< 0.04 J	< 0.041 J	< 0.041 J	< 0.04 J
	Aroclor 1232	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1242	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1248	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1254	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1260	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1262	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
	Aroclor 1268	µg/l	0.03	0.03	< 0.02 J	< 0.02 J	< 0.021 J	< 0.021 J	< 0.02 J
Volatile Organic Compounds									
	1,1,1,2-TETRACHLORROETHANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
	1,1,1-Trichloroethane	µg/l	200 (MTCA A)	42	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	1,1,2,2-TETRACHLOROETHANE	µg/l	4		NA	NA	< 0.5	< 0.5	< 0.5
	1,1,2-TRICHLOROETHANE	µg/l	16	42	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	1,1-DICHLOROETHANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
	1,1-DICHLOROETHYLENE	µg/l	7100		NA	NA	< 0.5	< 0.5	< 0.5
	1,1-Dichloropropene	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
	1,2,3-Trichlorobenzene	µg/l			NA	NA	< 2	< 2	< 2
	1,2,3-Trichloropropane	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
	1,2,4-Trichlorobenzene	µg/l	70		NA	NA	< 2	< 2	< 2
	1,2,4-TRIMETHYLBENZENE	µg/l			NA	NA	< 2	< 2	< 2
	1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	µg/l			NA	NA	< 2	< 2	< 2
	1,2-Dibromoethane	µg/l			NA	NA	< 2	< 2	< 2
	1,2-Dichlorobenzene	µg/l	1300		NA	NA	< 0.5	< 0.5	< 0.5
	1,2-DICHLOROETHANE	µg/l	37		NA	NA	< 0.5	< 0.5	< 0.5
	1,2-Dichloropropane	µg/l	15		NA	NA	< 0.5	< 0.5	< 0.5
	1,3,5-Trimethylbenzene	µg/l			NA	NA	< 2	< 2	< 2
	1,3-DICHLOROPROPANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
	1,4-Dichlorobenzene	µg/l	190		NA	NA	< 0.5	< 0.5	< 0.5
	2,2-Dichloropropane	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
	2-Butanone	µg/l			NA	NA	< 20	< 20	< 20
	2-CHLOROTOLUENE	µg/l			NA	NA	< 2	< 2	< 2
	2-PHENYLBUTANE	µg/l			NA	NA	< 2	< 2	< 2
	4-CHLOROTOLUENE	µg/l			NA	NA	< 2	< 2	< 2
	4-Methyl-2-Pentanone (MIBK)	µg/l			NA	NA	< 20	< 20	< 20
	ACETONE	µg/l			NA	NA	< 20	< 20	< 20
	Benzene	µg/l	51	71	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	AC-06A	AC-06A	MW-01	MW-213	TD-06A
			Sample ID	**AC-060A-1114**	**AC-06A-1114**	**MW-01-1114**	**MW-213-1114**	**TD-06A-1114**
			Sample Date	**11/5/2014**	**11/5/2014**	**11/5/2014**	**11/5/2014**	**11/5/2014**
			Sample Type	**FD**	**N**	**N**	**N**	**N**
			Parent Sample ID	**AC-06A-1114**				
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)					
BROMOBENZENE	µg/l			NA	NA	< 2	< 2	< 2
BROMODICHLOROMETHANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
BROMOMETHANE	µg/l			NA	NA	< 0.5 J	< 0.5 J	< 0.5 J
CARBON DISULFIDE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
CARBON TETRACHLORIDE	µg/l	1.6	4.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
CFC-11	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
CFC-12	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
CHLOROBENZENE	µg/l	1600		NA	NA	< 0.5	< 0.5	**0.12**
CHLOROBROMOMETHANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
CHLORODIBROMOMETHANE	µg/l	17		NA	NA	< 0.5	< 0.5	< 0.5
CHLOROETHANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
CHLOROFORM	µg/l	470		NA	NA	< 0.5	< 0.5	< 0.5
CHLOROMETHANE	µg/l			NA	NA	< 0.5 J	< 0.5 J	< 0.5 J
cis-1,2-Dichloroethene	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
cis-1,3-Dichloropropene	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
CYMENE	µg/l			NA	NA	< 2	< 2	< 2
DIBROMOMETHANE	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
DICHLOROMETHANE	µg/l	590		NA	NA	< 2	< 2	< 2
ETHYLBENZENE	µg/l	2100		NA	NA	< 0.5	< 0.5	< 0.5
Hexachlorobutadiene	µg/l	18		NA	NA	< 2	< 2	< 2
Isopropylbenzene	µg/l			NA	NA	< 2	< 2	< 2
m,p-Xylene	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
M-Dichlorobenzene	µg/l	960		NA	NA	< 0.5	< 0.5	< 0.5
METHYL N-BUTYL KETONE	µg/l			NA	NA	< 20	< 20	< 20
m-Xylene & p-Xylene	µg/l			NA	NA	< 0.11	< 0.11	< 0.11
Naphthalene	µg/l			NA	NA	< 2 J	< 2 J	< 2 J
n-Butylbenzene	µg/l			NA	NA	< 2	< 2	< 2
n-Propylbenzene	µg/l			NA	NA	< 2	< 2	< 2
o-Xylene	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
STYRENE (MONOMER)	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
tert-Butylbenzene	µg/l			NA	NA	< 2	< 2	< 2
Tetrachloroethene	µg/l	3.3	8.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Toluene	µg/l	15000		NA	NA	< 0.5	< 0.5	< 0.5
trans-1,2-Dichloroethene	µg/l	10000		NA	NA	< 0.5	< 0.5	< 0.5
trans-1,3-Dichloropropene	µg/l			NA	NA	< 0.5	< 0.5	< 0.5
TRIBOMOMETHANE	µg/l	140		NA	NA	< 0.5	< 0.5	< 0.5
TRICHLOROETHYLENE	µg/l	30		NA	NA	< 0.5	< 0.5	< 0.5
Vinyl Chloride	µg/l	150		NA	NA	< 0.5	< 0.5	< 0.5
Semi-volatile Organic Compounds								
1,2,4-Trichlorobenzene	µg/l			NA	NA	< 0.19 J	< 0.19	< 0.19
1,2-Dichlorobenzene	µg/l	1300		NA	NA	< 0.19	< 0.19	< 0.19
1,4-Dichlorobenzene	µg/l	190		NA	NA	< 0.19	< 0.19	< 0.19
2,4,5-TRICHLOROPHENOL	µg/l	3600		NA	NA	< 0.48	< 0.48	< 0.48
2,4,6-Trichlorophenol	µg/l			NA	NA	< 0.48	< 0.48	< 0.48
2,4-DICHLOROPHENOL	µg/l	290		NA	NA	< 0.48 J	< 0.48	< 0.48
2,4-Dimethyl Phenol	µg/l	850		NA	NA	< 3.8	< 3.8	< 3.8
2,4-DINITROPHENOL	µg/l	5300		NA	NA	< 3.8 J	< 3.8	< 3.8
2,4-DINITROTOLUENE	µg/l	3.4		NA	NA	< 0.19	< 0.19	< 0.19
2,6-DINITROTOLUENE	µg/l			NA	NA	< 0.19	< 0.19	< 0.19
2-Chlornaphthalene	µg/l	1600		NA	NA	< 0.19	< 0.19	< 0.19
2-CHLOROPHENOL	µg/l	150		NA	NA	< 0.48	< 0.48	< 0.48
2-Methylnaphthalene	µg/l			NA	NA	< 0.19 J	< 0.19	< 0.19

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	AC-06A	AC-06A	MW-01	MW-213	TD-06A
			Sample ID	**AC-060A-1114**	**AC-06A-1114**	**MW-01-1114**	**MW-213-1114**	**TD-06A-1114**
			Sample Date	**11/5/2014**	**11/5/2014**	**11/5/2014**	**11/5/2014**	**11/5/2014**
			Sample Type	**FD**	**N**	**N**	**N**	**N**
			Parent Sample ID	**AC-06A-1114**				
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)					
2-Methylphenol	µg/l			NA	NA	< 0.48	< 0.48	< 0.48
2-NITROANILINE	µg/l			NA	NA	< 0.19	< 0.19	< 0.19
2-NITROPHENOL	µg/l			NA	NA	< 0.48	< 0.48	< 0.48
3,3'-DICHLOROBENZIDINE	µg/l			NA	NA	< 1.9 R	< 1.9 R	< 1.9 R
3,5,5-TRIMETHYL-2-CYCLOHEXENE-1-ONE	µg/l			NA	NA	< 0.19	< 0.19	< 0.19
3-NITROANILINE	µg/l			NA	NA	< 0.95	< 0.95	< 0.95
4,6-Dinitro-2-Methylphenol	µg/l	280		NA	NA	< 1.9	< 1.9	< 1.9
4-BROMOPHENYL PHENYL ETHER	µg/l			NA	NA	< 0.19 J	< 0.19	< 0.19
4-Chloro-3-methylphenol	µg/l			NA	NA	< 0.48	< 0.48	< 0.48
4-CHLOROPHENYL PHENYL ETHER	µg/l			NA	NA	< 0.19	< 0.19	< 0.19
4-Methylphenol	µg/l			NA	NA	**0.14**	< 0.48	< 0.48
4-NITROPHENOL	µg/l			NA	NA	< 1.9 J	< 1.9 J	< 1.9 J
Acenaphthene	µg/l	990		NA	NA	< 0.19	< 0.19	**0.072**
Acenaphthylene	µg/l			NA	NA	< 0.19	< 0.19	< 0.19
ANTHRACENE	µg/l	40000		NA	NA	**0.04**	< 0.19	< 0.19
Benzo (a) anthracene	µg/l	0.018		NA	NA	< 0.19	< 0.19	< 0.19
Benzo (a) pyrene	µg/l	0.018		NA	NA	< 0.19	< 0.19	< 0.19
Benzo (b) fluoranthene	µg/l	0.018		NA	NA	< 0.19	< 0.19	< 0.19
Benzo (ghi) perylene	µg/l			NA	NA	< 0.19	< 0.19	< 0.19
Benzo (k) fluoranthene	ug/l	0.018		NA	NA	< 0.19	< 0.19	< 0.19
BENZOIC ACID	ug/l			NA	NA	< 4.8 J	< 4.8 UJ	< 4.8 UJ
BENZYL ALCOHOL	ug/l			NA	NA	< 0.48	< 0.48 J	< 0.48 J
bis(2-Chloroethoxy) Methane	ug/l			NA	NA	< 0.19	< 0.19	< 0.19
Bis-(2-Chloroethyl) Ether	ug/l	0.53		NA	NA	< 0.19	< 0.19	< 0.19
Bis(2-chloroisopropyl)ether	ug/l			NA	NA	< 0.19 J	< 0.19	< 0.19
bis(2-Ethylhexyl)phthalate	ug/l	2.2		NA	NA	**3.1**	< 0.95	< 0.95
Butyl Benzyl Phthalate	ug/l	1900		NA	NA	< 0.19	< 0.19	< 0.19
Chrysene	ug/l			NA	NA	< 0.19	< 0.19	< 0.19
Dibenz (a,h) anthracene	ug/l	0.018		NA	NA	< 0.19	< 0.19	< 0.19
DIBENZOFURAN	ug/l			NA	NA	< 0.19	< 0.19	< 0.19
Diethyl Phthalate	ug/l	44000		NA	NA	< 0.19	< 0.19	< 0.19
Dimethyl Phthalate	ug/l	1100000		NA	NA	< 0.19	< 0.19	< 0.19
Di-n-Butylphthalate	ug/l	4500		NA	NA	< 0.19	< 0.19 J	< 0.19 J
Di-n-Octyl phthalate	ug/l			NA	NA	< 0.19	< 0.19	< 0.19
FLUORANTHENE	ug/l	140		NA	NA	< 0.19	< 0.19 J	< 0.19 J
FLUORENE	ug/l	5300		NA	NA	< 0.19	< 0.19	< 0.19
HEXACHLOROBENZENE	ug/l	0.00029		NA	NA	< 0.19	< 0.19	< 0.19
Hexachlorobutadiene	ug/l	18		NA	NA	< 0.19 J	< 0.19	< 0.19
HEXACHLOROCYCLOPENTADIENE	ug/l	1000		NA	NA	< 0.95 R	< 0.95 R	< 0.95 R
HEXACHLOROETHANE	ug/l	3.3		NA	NA	< 0.19	< 0.19	< 0.19
Indeno (1,2,3-cd) pyrene	ug/l	0.018		NA	NA	< 0.19	< 0.19	< 0.19
M-Dichlorobenzene	ug/l	960		NA	NA	**0.051**	< 0.19	**0.094**
Naphthalene	ug/l			NA	NA	< 0.19 U	< 0.19	< 0.19
NITROBENZENE	ug/l	690		NA	NA	< 0.19	< 0.19	< 0.19
N-Nitroso-Di-N-Propylamine	ug/l	0.51		NA	NA	< 0.19	< 0.19	< 0.19
N-NITROSODIPHENYLAMINE	ug/l	6		NA	NA	< 0.19	< 0.19	< 0.19
P-CHLOROANILINE	ug/l			NA	NA	< 0.19 R	< 0.19 R	< 0.19 R
PENTACHLOROPHENOL	ug/l	3		NA	NA	< 0.95	< 0.95	< 0.95
PHENANTHRENE	ug/l			NA	NA	< 0.19	< 0.19	< 0.19
PHENOL	ug/l	1700000		NA	NA	**0.14**	< 0.48	< 0.48
P-NITROANILINE	ug/l			NA	NA	< 0.95	< 0.95 J	< 0.95 J
PYRENE	ug/l	4000		NA	NA	< 0.19	< 0.19 J	< 0.19 J

Table B-2- Comprehensive S&G-OU1 Groundwater Data Summary

			Location	AC-06A	AC-06A	MW-01	MW-213	TD-06A
			Sample ID	AC-060A-1114	AC-06A-1114	MW-01-1114	MW-213-1114	TD-06A-1114
			Sample Date	11/5/2014	11/5/2014	11/5/2014	11/5/2014	11/5/2014
			Sample Type	FD	N	N	N	N
			Parent Sample ID	AC-06A-1114				
Chemical Name	Unit	NRWQC	ROD CUGs (µg/l)					
Semi-volatile Organic Compounds (SIM)								
2-Methylnaphthalene	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
Acenaphthene	ug/l			NA	NA	< 0.019	< 0.02	**0.051**
Acenaphthylene	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
ANTHRACENE	ug/l			NA	NA	**0.02**	< 0.02	< 0.019
Benzo (a) anthracene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
Benzo (a) pyrene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
Benzo (b) fluoranthene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
Benzo (ghi) perylene	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
Benzo (k) fluoranthene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
Chrysene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
Dibenz (a,h) anthracene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
DIBENZOFURAN	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
FLUORANTHENE	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
FLUORENE	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
Indeno (1,2,3-cd) pyrene	ug/l	.018		NA	NA	< 0.019	< 0.02	< 0.019
Naphthalene	ug/l			NA	NA	< 0.056	< 0.02	< 0.019
PHENANTHRENE	ug/l			NA	NA	< 0.019	< 0.02	< 0.019
PYRENE	ug/l			NA	NA	< 0.019	< 0.02	< 0.019

Notes:

Bold = detected concentration

ROD CUG = Record of Decision cleanup goal

NRWQC - National Recommended Water Quality Criteria (Lower of acute or chronic saltwater criteria or Human Health

Sample Type Key:

N = Normal Sample

FD = Field Duplicate

Qualifier Key:

R = Rejected Concentration

J = Estimated Concentration

J+ = Estimated Concentration, biased high

< 0.3 = Concentration not detected above the method reporting limit

NA = Not Analyzed

Table B-3. LU OU3, Summary of Semi-Annual Sampling (Oct 2010-Oct 2014)

Well	Benzene (ug/L)		Tetrachloroethene (ug/L)		Copper (ug/L)		Lead (ug/L)		Zinc (ug/L)	
CUL	71		8.8		2.9		2.8		76.6	
	min	max	min	max	min	max	min	max	min	max
LMW3	ND	0.15 J	0.04 J	***13***	0.36	***3.2***	--	--	11.1	***512***
LMW25	ND	0.72	ND	ND	0.64	2.3	--	--	3	40.8
LMW7	ND	ND	1.7	4.3	--	--	0.029	1.2	--	--
LMW18	ND	ND	ND	1.9	1.46	***5.17***	0.156	2.57	--	--
LMW9	ND	6.1	ND	3.1	0.84	***7.61***	--	--	--	--
LMW12	ND	0.25 J	0.10 J	***20***	1.13	***88.6***	--	--	--	--
LMW27	ND	0.37 J	5.3	***30***	2.6	***4.99***	--	--	61.6	***391***
LMW26	ND	0.07 J	***10***	***22***	2.78	***24.1***	--	--	21.2	42.8

highlighted indicates exceendence of the CUL

Table B-4 - Summary of October 2014 Comprehensive Sampling (Uplands and Shoreline Monitoring Programs) for LU-OU3

		Well Number	LMW3	LMW35a	LMW7	LMW9	LMW12	LMW18	LMW25	LMW26	LMW36b	LMW27	LMW30	LMW31	LMW32S	LMW32D	LMW33	LMW34	BG-01	BG-02	BG-03
		Sample Date	10/7/14	10/7/14	10/6/14	10/6/14	10/6/14	10/6/14	10/7/14	10/6/14	10/6/14	10/6/14	10/8/14	10/7/14	10/7/14	10/7/14	10/7/14	10/6/14	10/8/14	10/8/14	10/7/14
		Sample Time	12:30	14:00	10:22	10:27	11:50	13:04	12:20	08:49	08:36	08:44	10:07	13:50	09:31	09:26	11:02	11:50	11:26	10:10	10:55
			Upland	--	Upland	Upland	Upland	Upland/ Shoreline	Upland	Upland/ Shoreline	--	Upland	Shorelin	Shoreline	Shoreline	Shoreline	Shoreline	Shoreline	Back-ground	Back-ground	Back-ground
	NRWQC	ROD																			
VOCs (8260C) µg/L																					
DCDFMA			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Chloromethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vinyl Chloride	150		***0.080 J d***	<0.5	<0.5	<0.5	***0.26 J***	***0.18 J***	<0.5	<0.5	***0.090 J***	<0.5	<0.5	<0.5	<0.5	***0.090 J***	<0.5	<0.5	<0.5	<0.5	<0.5
Bromomethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TCFMA			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethene (1,1-DCE)	7100		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***0.090 J***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acetone			<20	***3.4 J***	<20	***3.4 J***	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Carbon Disulfide			<0.5	<0.5	<0.5	<0.5	***0.080 J***	<0.5	***0.070 J***	<0.5	<0.5	<0.5	***0.070 J***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Methylene Chloride	590		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.12 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
trans-1,2-Dichloroethene	10,000		<0.5	<0.5	<0.5	<0.5	***0.13 J***	***0.30 J***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane (1,1-DCA)			<0.5	<0.5	<0.5	<0.5	***3.2***	***0.29 J***	<0.5	***0.22 J***	***0.20 J***	***0.79***	***0.38 J***	<0.5	<0.5	<0.5	<0.5	<0.5	***0.10 J***	<0.5	***0.080 J***
2,2-Dichloropropane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1,2-Dichloroethene			***1.1***	***1.0***	***0.77***	***0.13 J***	***17***	***1.2***	<0.5	***1.7***	***1.5***	***1.8***	***0.16 J***	<0.5	<0.5	<0.5	<0.5	***1.4***	<0.5	***0.19 J***	***2.4***
2-Butanone (MEK)			<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Bromochloromethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroform	470		<0.5	<0.5	***0.080 J***	<0.5	<0.5	<0.5	<0.5	***0.23 J***	***0.25 J***	***0.59***	<0.5	<0.5	<0.5	<0.5	<0.5	***0.24 J***	<0.5	<0.5	<0.5
1,1,1-Trichloroethane (TCA)	200 (MTCA -A)		<0.5	<0.5	<0.5	<0.5	***0.19 J***	<0.5	<0.5	***0.44 J***	***0.48 J***	***1.3***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride	1.6		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloropropene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzene	51	71	<0.5	<0.5	<0.5	<0.5	***0.16 J***	<0.062	***0.66***	<0.5	<0.5	<0.5	***0.32 J***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane (EDC)	37		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethene (TCE)	30		***0.12 J***	***0.10 J***	***0.53***	<0.5	***1.3***	***0.16 J***	<0.5	***1.0***	***1.0***	***0.74***	<0.5	<0.5	<0.5	<0.5	<0.5	***0.88***	<0.5	***0.16 J***	<0.5
1,2-Dichloropropane	15		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromomethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1,3-Dichloropropene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Methyl-2-pentanone (MIBK)			<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Toluene	15,000		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***0.83***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1,3-Dichloropropene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	16		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachloroethene (PCE)	3.3	8.8	***0.40 J***	***0.24 J***	***1.8***	***0.34 J***	***9.6***	<0.5	<0.5	***19***	***20***	***21***	<0.5	***0.39 J***	<0.5	<0.5	***0.14 J***	***3.9***	<0.5	***0.30 J***	<0.5
2-Hexanone			<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
1,3-Dichloropropane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane	17		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dibromoethane (EDB)			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chlorobenzene	1,600		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***88 D***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	2,100		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***0.070 J***	<0.5	<0.5	<0.5	***0.15 J***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,1,2-Tetrachloroethane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***2.1***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***0.76***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform	140		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Isopropylbenzene			***0.060 J***	<2.0	<2.0	<2.0	<2.0	<2.0	***0.060 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,1,2,2-Tetrachloroethane	4.0		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromobenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
n-Propylbenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.12 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,2,3-Trichloropropane			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorotoluene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.26 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,3,5-Trimethylbenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.13 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
4-Chlorotoluene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
tert-Butylbenzene			<2.0	<2.0	<2.0	0.22 J	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,2,4-Trimethylbenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.25 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
sec-Butylbenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Table B-4 - Summary of October 2014 Comprehensive Sampling (Uplands and Shoreline Monitoring Programs) for LU-OU3

		Well Number	**LMW3**	**LMW35[a]**	**LMW7**	**LMW9**	**LMW12**	**LMW18**	**LMW25**	**LMW26**	**LMW36[b]**	**LMW27**	**LMW30**	**LMW31**	**LMW32S**	**LMW32D**	**LMW33**	**LMW34**	**BG-01**	**BG-02**	**BG-03**
		Sample Date	**10/7/14**	**10/7/14**	**10/6/14**	**10/6/14**	**10/6/14**	**10/6/14**	**10/7/14**	**10/6/14**	**10/6/14**	**10/6/14**	**10/8/14**	**10/7/14**	**10/7/14**	**10/7/14**	**10/7/14**	**10/6/14**	**10/8/14**	**10/8/14**	**10/7/14**
		Sample Time	**12:30**	**14:00**	**10:22**	**10:27**	**11:50**	**13:04**	**12:20**	**08:49**	**08:36**	**08:44**	**10:07**	**13:50**	**09:31**	**09:26**	**11:02**	**11:50**	**11:26**	**10:10**	**10:55**
			Upland	**--**	**Upland**	**Upland**	**Upland**	**Upland/ Shoreline**	**Upland**	**Upland/ Shoreline**	**--**	**Upland**	**Shorelin**	**Shoreline**	**Shoreline**	**Shoreline**	**Shoreline**	**Shoreline**	**Back-ground**	**Back-ground**	**Back-ground**
	NRWQC	**ROD**																			
4-Isopropyltoluene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.070 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,3-Dichlorobenzene	960		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***0.23 J***	***0.20 J***	***0.13 J***	***1.1***	<0.5	<0.5	<0.5	<0.5	0.10 J	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	190		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***53***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Butylbenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,2-Dichlorobenzene	1,300		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***1.1***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dibromo-3-chloropropane			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,2,4-Trichlorobenzene	70		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hexachlorobutadiene	18		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Naphthalene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	***0.30 J***	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1,2,3-Trichlorobenzene			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
SVOCs (8270D) µg/L																					
Bis(2-chloroethyl)ether	0.53		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Phenol	1,700,000		<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
2-Chlorophenol	150		<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	***0.071 J***	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
1,3-Dichlorobenzene	960		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.036 J***	***0.049 J***	***0.039 J***	***0.71***	<0.19	<0.19	<0.19	<0.19	***0.052 J***	<0.19	<0.19	<0.19
1,4-Dichlorobenzene	190		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***33 D***	<0.19	<0.19	<0.19	<0.19	***0.046 J***	<0.19	<0.19	<0.19
1,2-Dichlorobenzene	1,300		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.83***	<0.19	<0.19	<0.19	<0.19	***0.085 J***	<0.19	<0.19	<0.19
Benzyl Alcohol			<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
Bis(2-chloroisopropyl) Ether			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
2-Methylphenol			<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
Hexachloroethane	3.3		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
N-Nitroso-di-n-propylamine	0.51		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
4-Methylphenol			<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	0.13 J	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
Nitrobenzene	690		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Isophorone	960		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
2-Nitrophenol			<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
2,4-Dimethylphenol	850		<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8
Bis(2-chloroethoxy)methane			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
2,4-Dichlorophenol	290		<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	0.061 J	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
Benzoic Acid			***1.7 J***	***1.6 J***	***1.3 J***	<1.1	***1.3 J***	***2.0 J***	***3.2 J***	***1.2 J***	<4.8	***1.4 J***	***1.8 J***	***1.4 J***	***1.3 J***	***1.5 J***	***1.3 J***	***1.2 J***	***1.4 J***	***1.3 J***	***1.5 J***
1,2,4-Trichlorobenzene			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Naphthalene			***0.032 J***	***0.031 J***	***0.026 J***	<0.19	<0.19	<0.19	0.19 J	<0.19	<0.19	***0.031 J***	***0.074 J***	<0.19	<0.19	<0.19	<0.19	***0.029 J***	<0.19	<0.19	<0.19
4-Chloroaniline			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Hexachlorobutadiene	18		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
4-Chloro-3-methylphenol			<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
2-Methylnaphthalene			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.052 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Hexachlorocyclopentadiene	1,000		<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95
2,4,6-Trichlorophenol	3,600		<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
2,4,5-Trichlorophenol			<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48	<0.48
2-Chloronaphthalene	1,600		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
2-Nitroaniline			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Acenaphthylene			***0.045 J***	***0.044 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.029 J***
Dimethylphthalate	1,100,000		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	0.029 J	<0.19	<0.19	<0.19	<0.19	<0.19
2,6-Dinitrotoluene			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Acenaphthene	990		***9.0***	***7.9***	<0.19	***14 D***	<0.19	<0.19	***0.12 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.088 J***	<0.19	***0.028 J***	<0.19
3-Nitroaniline			<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95
2,4-Dinitrophenol	5,300		<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8
Dibenzofuran			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.033 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
4-Nitrophenol			<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
2,4-Dinitrotoluene	3.4		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Fluorene	5,300		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.090 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
4-Chlorophenyl-Phenylether			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Diethylphthalate	44,000		<0.19	<0.19	<0.19	<0.19	***0.030 J***	<0.19	***0.021 J***	<0.19	<0.19	<0.19	***0.045 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
4-Nitroaniline			<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95
2-Methyl-4,6-dinitrophenol	280		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9

Table B-4 - Summary of October 2014 Comprehensive Sampling (Uplands and Shoreline Monitoring Programs) for LU-OU3

Well Number			LMW3	LMW35[a]	LMW7	LMW9	LMW12	LMW18	LMW25	LMW26	LMW36[b]	LMW27	LMW30	LMW31	LMW32S	LMW32D	LMW33	LMW34	BG-01	BG-02	BG-03
Sample Date			10/7/14	10/7/14	10/6/14	10/6/14	10/6/14	10/6/14	10/7/14	10/6/14	10/6/14	10/6/14	10/8/14	10/7/14	10/7/14	10/7/14	10/7/14	10/6/14	10/8/14	10/8/14	10/7/14
Sample Time			12:30	14:00	10:22	10:27	11:50	13:04	12:20	08:49	08:36	08:44	10:07	13:50	09:31	09:26	11:02	11:50	11:26	10:10	10:55
			Upland	--	Upland	Upland	Upland	Upland/ Shoreline	Upland	Upland/ Shoreline	--	Upland	Shorelin	Shoreline	Shoreline	Shoreline	Shoreline	Shoreline	Back-ground	Back-ground	Back-ground
	NRWQC	ROD																			
N-Nitrosodiphenylamine	6.0		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
4-Bromophenyl-Phenylether			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Hexachlorobenzene	0.00029		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pentachlorophenol	3.0		<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95
Phenanthrene			<0.19	<0.19	***0.046 J***	<0.19	<0.19	<0.19	***0.081 J***	***0.036 J***	***0.026 J***	***0.039 J***	<0.19	<0.19	<0.19	<0.19	<0.19	***0.032 J***	<0.19	<0.19	<0.19
Anthracene	40,000		***0.050 J***	***0.052 J***	<0.19	<0.19	***0.031 J***	***0.040 J***	***0.038 J***	<0.19	<0.19	<0.19	***0.054 J***	<0.19	***0.046 J***	***0.045 J***	<0.19	<0.19	***0.11 J***	<0.19	***0.088 J***
Di-n-butylphthalate	4,500		<0.19	<0.19	***0.043 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.033 J***	<0.19	<0.19	<0.19	***0.038 J***	<0.19
Fluoranthene	140		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.045 J***	<0.19	***0.027 J***	<0.19	***0.040 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Pyrene	4,000		<0.19	<0.19	<0.19	***0.16 J***	***0.036 J***	***0.075 J***	***0.042 J***	<0.19	***0.021 J***	<0.19	***0.051 J***	***0.022 J***	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	***0.026 J***
Butylbenzylphthalate	1,900		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
3,3'-Dichlorobenzidine			<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
Benzo(a)anthracene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Chrysene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Bis(2-ethylhexyl)phthalate	2.2		<0.95	<0.95	<0.95	***0.36 J***	***0.17 J***	<0.95	<0.95	<0.95	***0.21 J***	<0.95	<0.95	***0.18 J***	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95	<0.95
Di-n-octylphthalate			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Benzo(b)fluoranthene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Benzo(k)fluoranthene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Benzo(a)pyrene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Indeno(1,2,3-cd)pyrene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Dibenz(a,h)anthracene	0.018		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Benzo(g,h,i)perylene			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
PCBs (8082A) µg/L																					
PCB1016	0.03		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PCB1221	0.03		<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
PCB1232	0.03		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PCB1242	0.03		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PCB1248	0.03		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PCB1254	0.03		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
PCB1260	0.03		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Pesticides (8081B) µg/L																					
alpha-BHC	0.0049		<0.011	<0.011	<0.011	<0.011 i[b]	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
beta-BHC	0.017		<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
gamma-BHC (Lindane)	1.8		<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011
delta-BHC			<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Heptachlor	0.000079		<0.011 i	<0.011	<0.011 i	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011 i
Aldrin	0.000050		<0.011	<0.011	<0.011	<0.011 i	***0.0023 JP***	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011 i
Heptachlor Epoxide	0.000039		<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011 i	<0.011	<0.011
gamma-Chlordane	0.00081		<0.011	<0.011	0.00067 J	<0.011 i	***0.0019 JP***	<0.011	<0.011	<0.011	<0.00034 i	***0.00042 J***	<0.011	***0.00040 JP***	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011
Endosulfan I	0.0087		<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011 i
alpha-Chlordane	0.00081		<0.011	<0.011	<0.011	<0.0041	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Dieldrin	0.000054		<0.011	<0.011 i	<0.011	<0.011 i	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011
4,4'-DDE	0.00022		<0.011 i	<0.011 i	<0.011 i	<0.011 i	<0.011 i	<0.011	***0.0010 J***	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011 i
Endrin	0.0023		<0.011	<0.011	<0.011	<0.011 i	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Endosulfan II	0.0087		<0.011	<0.011 i	<0.011	<0.011 i	<0.011 i	<0.011 i	<0.011 i	***0.00087 J***	***0.00094 J***	<0.011 i	<0.011 i	<0.011	***0.00070 J***	***0.00099 J***	<0.011	<0.011 i	<0.011	<0.011 i	<0.011 i
4,4'-DDD	0.00031		<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Endrin Aldehyde	0.30		<0.011	<0.011	0.00087 i	<0.011 i	<0.011	<0.011	***0.00063 JP***	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i
Endosulfan Sulfate	89		<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011
4,4'-DDT	0.00022		***0.00068 J***	<0.011	<0.011 i	<0.011 i	<0.011	<0.011	<0.011 i	<0.011	<0.011 i	<0.011	***0.0029 J***	<0.011 i	<0.011	<0.011	***0.00071 J***	<0.011 i	<0.011 i	<0.011 i	<0.011 i
Endrin Ketone			<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Methoxychlor			<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011 i	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Toxaphene	0.00020		<0.50	<0.50	<0.50 i	<0.50 i	<0.50 i	<0.50	<0.50	<0.50	<0.50	<0.011 i	<0.081 i	<0.50	<0.50	<0.50	<0.50	<0.50 i	<0.50	<0.50	<0.50
TPH Diesel µg/L																					
Diesel Range Organics (DRO)	500 (MTCA-A)		***200 J***	***190 J***	***300 Y***	***1800 Y***	***350 Y***	***78 J***	***110 J***	***38 J***	***44 J***	***120 J***	***300 Y***	***35 J***	***23 J***	***72 J***	***22 J***	***240 J***	***170 J***	***200 J***	***160 J***
Residual Range Organics (RRO)	500 (MTCA-A)		***260 J***	***250 J***	***480 J***	***910 L***	***580 L***	***180 J***	***160 J***	***120 J***	***130 J***	***230 J***	***540 O***	***130 J***	***72 J***	***140 J***	***74 J***	***450 J***	***320 J***	***350 J***	***190 J***
TPH Gasoline (GRO) µg/L																					

Table B-4 - Summary of October 2014 Comprehensive Sampling (Uplands and Shoreline Monitoring Programs) for LU-OU3

Well Number			LMW3	LMW35[a]	LMW7	LMW9	LMW12	LMW18	LMW25	LMW26	LMW36[b]	LMW27	LMW30	LMW31	LMW32S	LMW32D	LMW33	LMW34	BG-01	BG-02	BG-03
Sample Date			10/7/14	10/7/14	10/6/14	10/6/14	10/6/14	10/6/14	10/7/14	10/6/14	10/6/14	10/6/14	10/8/14	10/7/14	10/7/14	10/7/14	10/7/14	10/6/14	10/8/14	10/8/14	10/7/14
Sample Time			12:30	14:00	10:22	10:27	11:50	13:04	12:20	08:49	08:36	08:44	10:07	13:50	09:31	09:26	11:02	11:50	11:26	10:10	10:55
			Upland	--	Upland	Upland	Upland	Upland/ Shoreline	Upland	Upland/ Shoreline	--	Upland	Shorelin	Shoreline	Shoreline	Shoreline	Shoreline	Shoreline	Back-ground	Back-ground	Back-ground
	NRWQC	**ROD**																			
Gasoline Range Organics-NWTPH	800 (MTCA-A)		<250	<250	<250	***62 J***	<250	<250	***25 J***	<250	<250	<250	***200 J***	<250	<250	<250	<250	<250	<250	<250	<250
Metals µg/L																					
Antimony (Total)	640		<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Antimony (Dissolved)	640		<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Arsenic (Total)	0.14		***0.4 Jd***	***0.3 J***	***0.5***	***0.9***	***2.4***	***10.2***	***5.6***	***0.3 J***	***0.5 J***	***0.6***	***0.11 Jb***	***2***	***6.2***	***0.20 J***	***0.31 J***	***1.5***	***0.4 J***	***0.45 J***	***2.2***
Arsenic (Dissolved)	0.14		***0.1 J***	***0.2 J***	***0.5***	***0.9***	***3.1***	***6.7***	***4.4***	***0.3 J***	***0.2 J***	***0.7***	***0.07 J***	***1.1***	***6***	***0.19 J***	***0.29 J***	***1.1***	***0.4 J***	***0.03 J***	***1***
Cadmium (Total)	8.8		***0.50 J***	<1.0	<1.0	<1.0	***2.6***	<1.0	<1.0	<1.0	<1.0	***3.8***	<1.0	***0.60 J***	<1.0	<1.0	***0.80 J***	<1.0	<1.0	<1.0	<1.0
Cadmium (Dissolved)	8.8		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	***3.7***	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper (Total)	3.1	2.9	***0.36***	***0.23***	***1.07***	***0.84***	***3.97***	***3.7***	***1.53***	***12.1***	***10.6***	***3.1***	***0.478***	***161***	***2.3***	***0.168***	***1.88***	***2.74***	***2.08***	***1.9***	***0.2***
Copper (Dissolved)	3.1	2.9	***0.08 J***	***0.07 J***	***0.79***	***0.29***	***0.44***	***0.85***	***0.27***	***7.53***	***6.98***	***2.2***	***0.167***	***12.4***	***2.49***	***0.229***	***2.14***	***1.14***	***1.89***	***0.671***	***0.14***
Lead (Total)	8.1	5.8	***0.079***	***0.04***	***1.2***	***0.42***	***3.46***	***0.453***	***0.669***	***0.388***	***0.446***	***0.185***	***0.638***	***7.24***	***0.084***	***0.106***	***0.033***	***0.082***	***0.035***	***1.44***	***0.109***
Lead (Dissolved)	8.1	5.8	***0.008 J***	***0.006 J***	***0.032***	***0.128***	***0.229***	***0.028***	***0.014 J***	***0.07***	***0.046***	***0.044***	***0.031***	***0.076***	***0.031***	***0.04***	***0.22***	***0.087***	***0.015 J***	***0.048***	***0.182***
Mercury (Total)	0.94		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.02 J	<0.20	<0.20	<0.20	***0.05 J***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Mercury (Dissolved)	0.94		<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Nickel (Total)	8.2		***1.8 J***	***1.3 J***	***8.1***	***0.6 J***	***2.8 J***	***1.3 J***	***2.1 J***	***5.6***	***6.2***	***29.7***	***1.2 J***	***14.4***	***4.4***	***1.6 J***	***30.3***	***2.0 J***	***2.7 J***	***10***	***1.2 J***
Nickel (Dissolved)	8.2		***1.3 J***	***1.8 J***	***8.1***	<0.4	***1.4 J***	***1.0 J***	***1.1 J***	***5.7***	***5.7***	***29***	***1.6 J***	***2.6 J***	***4.4***	***0.5 J***	***30.8***	***1.4 J***	***3.5 J***	***10***	***1.4 J***
Selenium (Total)	71		<1.0	<1.0	<1.0	***0.8 J***	***0.6 J***	***1.2***	***0.8 J***	***0.4 J***	***0.4 J***	***0.7 J***	<1.0	***0.25 J***	<1.0	<1.0	<1.0	***0.6 J***	***0.7 J***	<1.0	<1.0
Selenium (Dissolved)	71		<1.0	<1.0	<1.0	***0.6 J***	***0.9 J***	***1.0 J***	***0.6 J***	***0.3 J***	<1.0	***0.6 J***	<1.0	<1.0	<1.0	<1.0	<1.0	***0.5 J***	***0.9 J***	<1.0	***0.5 J***
Thallium (Total)	0.47		<0.02	<0.02	***0.008 J***	<0.02	***0.01 J***	<0.02	***0.006 J***	***0.013 J***	***0.02***	***0.034***	<0.02	***0.014 J***	***0.024***	<0.02	***0.154***	***0.012 J***	***0.014 J***	***0.042***	***0.008 J***
Thallium (Dissolved)	0.47		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	***0.010 J***	***0.01 J***	***0.031***	<0.02	***0.010 J***	***0.024***	<0.02	***0.157***	***0.01 J***	***0.021***	***0.035***	<0.005
Zinc (Total)	81	76.6	11.1	***8.1***	***3.6 J***	***3.5 J***	***60.2***	***10.5***	***20.3***	***26.2***	***30.2***	***230***	***0.7 J***	***140***	***68.2***	<4.0	***26.9***	***8.9***	***1.2 J***	***166***	<4.0
Zinc (Dissolved)	81	76.6	4.9 J	***4.9 J***	***2.3 J***	***1.7 J***	***19.2***	***4.9***	<5.0	***25.6***	***25.8***	***204***	<4.0	***43.6***	***66***	<4.0	***28.7***	***4.8***	***0.8 J***	***154***	<4.0
Cyanide µg/L																					
Cyanide Available	1		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

[a] Sample LMW35 is duplicate sample collected concurrently with sample LMW3.

[b] Sample LMW36 is duplicate sample collected concurrently with sample LMW26.

[c] Unless otherwise noted, screening levels are ambient water quality criteria for human health for the consumption of organisms.

J = Indicates compound is reported at an estimated concentration below the laboratory reporting limit but above the method detection limit.

D = The reported result is from a dilution.

i = The method reporting limit/method detection limit is elevated due to a chromatographic interference.

P = The Gas Chromatography confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.

Y = The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.

L = The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.

O = The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.

<5 = Indicates the compound was not detected at the associated laboratory reporting limit.

Bold indicated detected concentration

Yellow highlight indicates ROD CUL exceedence, grey highlight indicates NRWQC exceedence

Table B-5- LSSOU Groundwater Exceedences of Screening Criteria

Well	Sampling Event	Tetrachloro-ethene (PCE) (ug/L)	Diesel Range Organics (DRO) (ug/L)	Residual Range Organics (RRO) (ug/L)	Arsenic (Dissolved) (ug/L)	Copper (Dissolved) (ug/L)	Nickel (Dissolved) (ug/L)	Zinc (Dissolved) (ug/L)
NRWQC-marine		**--**			**36**	**3.1**	**8.2**	**81**
NRWQC-HH		**3.3**	**500 (MTCA-A)**	**500 (MTCA-A)**	**0.14**	**--**	**46,000**	**26,000**
ROD CUL		**8.8**			**--**	**2.9**	**--**	**76.6**
BG-01	October-10	<	NA	NA	0.54	<	<	<
BG-01	April-11	<	NA	NA	0.44 J	<	<	<
BG-01	October-11	<	NA	NA	<	<	<	<
BG-01	April-12	<	NA	NA	0.5 J	<	<	<
BG-01	October-12	<	NA	NA	0.26 J	<	<	<
BG-01	April-13	<	NA	NA	0.40 J	<	<	<
BG-01	October-13	<	NA	NA	0.025 J	<	<	<
BG-01	April-14	<	NA	NA	0.3 J	3.14	<	<
BG-01	October-14	<	<	<	0.4 J	<	<	<
BG-02	October-10	<	NA	NA	0.17 J	<	<	<
BG-02	April-11	<	NA	NA		<	<	<
BG-02	October-11	<	NA	NA	0.55 J	<	16	317
BG-02	April-12	<	NA	NA	0.2 J	<	8.76	167
BG-02	October-12	<	NA	NA	0.12 J	<	9.69	163
BG-02	April-13	<	NA	NA	<	<	28.7	464
BG-02	October-13	<	NA	NA	0.18 J	<	41.6	646
BG-02	April-14	<	NA	NA	0.5 J	<	21.4	426
BG-02	October-14	<	<	<	<	<	10	154
BG-03	October-10	<	NA	NA	1.25	<	<	<
BG-03	April-11	<	NA	NA	1.1	<	<	<
BG-03	October-11	<	NA	NA	0.98	<	<	<
BG-03	April-12	<	NA	NA	<	<	<	<
BG-03	October-12	<	NA	NA	2.52	<	<	<
BG-03	April-13	<	NA	NA	1.45	<	<	<
BG-03	October-13	<	NA	NA	1.5	<	<	<
BG-03	April-14	<	NA	NA	0.4 J	<	<	<
BG-03	October-14	<	<	<	1	<	<	<
LMW18	October-10	<	NA	NA	6.62	<	<	<
LMW18	April-11	<	NA	NA	5.1	<	<	<
LMW18	October-11	<	NA	NA	6.8	<	<	<
LMW18	April-12	<	NA	NA	<	<	<	<
LMW18	October-12	<	NA	NA	9.89	<	<	<
LMW18	April-13	<	NA	NA	2.66	<	<	<
LMW18	October-13	<	NA	NA	5.05	<	<	<
LMW18	April-14	<	NA	NA	2.9	<	<	<
LMW18	October-14	<	<	<	6.7	<	<	<
LMW26	October-10	17	NA	NA	0.49 J	7.07	<	<
LMW26	April-11	19	NA	NA	0.41 J	3.07	<	<
LMW26	October-11	10	NA	NA	0.18 J	6.78	<	<
LMW26	April-12	14	NA	NA	<	3.23	<	<
LMW26	October-12	16	NA	NA	0.31 J	20.4	<	<
LMW26	April-13	16	NA	NA	0.54	<	<	<
LMW26	October-13	22	NA	NA	<	5.8	11.6	<
LMW26	April-14	15	NA	NA	<	<	<	<
LMW26	October-14	19	<	<	0.3 J	7.53	<	<
LMW30	October-10	<	NA	NA	0.38 J	<	<	<
LMW30	April-11	<	NA	NA		<	<	<
LMW30	October-11	<	NA	NA	0.20 J	<	<	<
LMW30	April-12	<	NA	NA	<	<	<	<
LMW30	October-12	<	<	<	<	<	<	<
LMW30	April-13	<	540 Y	650 O	0.48 J	<	<	<
LMW30	October-13	<	<	<	<	<	<	<

Table B-5- LSSOU Groundwater Exceedences of Screening Criteria

Well	Sampling Event	Tetrachloro-ethene (PCE) (ug/L)	Diesel Range Organics (DRO) (ug/L)	Residual Range Organics (RRO) (ug/L)	Arsenic (Dissolved) (ug/L)	Copper (Dissolved) (ug/L)	Nickel (Dissolved) (ug/L)	Zinc (Dissolved) (ug/L)
NRWQC-marine		**--**			**36**	**3.1**	**8.2**	**81**
NRWQC-HH		**3.3**	**500 (MTCA-A)**	**500 (MTCA-A)**	**0.14**	**--**	**46,000**	**26,000**
ROD CUL		**8.8**			**--**	**2.9**	**--**	**76.6**
LMW30	April-14	<	<	<	<	<	<	<
LMW30	October-14	<	<	540 O	<	<	<	<
LMW31	October-10	<	NA	NA	1.66	11.8	<	<
LMW31	April-11	<	NA	NA	1.32	9.84	<	<
LMW31	October-11	<	NA	NA	1.43	12.7	<	<
LMW31	April-12	<	NA	NA	1.81	17.1	<	<
LMW31	October-12	<	<	<	1.66	23.8	<	<
LMW31	April-13	<	<	<	1.52	16.5	<	<
LMW31	October-13	<	<	<	1.19	21.1	<	<
LMW31	April-14	<	<	<	1.2	8.39	<	<
LMW31	October-14	<	<	<	1.1	12.4	<	<
LMW32D	October-10	<	NA	NA	0.21 J	<	<	<
LMW32D	April-11	<	NA	NA	0.21 J	<	<	<
LMW32D	October-11	<	NA	NA	0.26 J	<	<	<
LMW32D	April-12	<	NA	NA	0.31 J	<	<	<
LMW32D	October-12	<	NA	NA	0.20 J	<	<	<
LMW32D	April-13	<	NA	NA	0.32 J	<	<	<
LMW32D	October-13	<	<	<	0.22 J	<	<	<
LMW32D	April-14	<	NA	NA	0.26 J	<	<	<
LMW32D	October-14	<	<	<	0.19 J	<	<	<
LMW32S	October-10	<	NA	NA	10.7	4.02	<	<
LMW32S	April-11	<	NA	NA	4.67	<	<	<
LMW32S	October-11	<	NA	NA	4.01	3.9	<	90.8
LMW32S	April-12	<	NA	NA	8.16	3.08	<	<
LMW32S	October-12	<	NA	NA	5.24	<	<	79.4
LMW32S	April-13	<	NA	NA	5.35	<	<	<
LMW32S	October-13	<	NA	NA	4.86	<	<	<
LMW32S	April-14	<	NA	NA	6.3	<	<	<
LMW32S	October-14	<	<	<	6	<	<	<
LMW33	October-10	<	NA	NA	0.34 J	<	59	<
LMW33	April-11	<	NA	NA	1.9	9.51	9.59	<
LMW33	October-11	<	NA	NA	0.22 J	7.52	68.8	117
LMW33	April-12	<	NA	NA	0.25 J	3.82	32.4	<
LMW33	October-12	<	NA	NA	0.26 J	<	50.1	<
LMW33	April-13	<	NA	NA	0.24 J	<	27.9	<
LMW33	October-13	<	NA	NA	0.25 J	<	37.4	<
LMW33	April-14	<	NA	NA	0.28 J	<	16.1	107
LMW33	October-14	<	<	<	0.29 J	<	30.8	<
LMW34	October-10	<	NA	NA	2.41	<	<	<
LMW34	April-11	<	NA	NA	1.33	<	<	<
LMW34	October-11	<	NA	NA	1.16	<	<	<
LMW34	April-12	<	NA	NA	0.7	<	<	<
LMW34	October-12	<	NA	NA	1.17	<	<	<
LMW34	April-13	<	NA	NA	0.41 J	<	<	<
LMW34	October-13	<	NA	NA	0.92	<	<	<
LMW34	April-14	<	NA	NA	0.8	<	<	<
LMW34	October-14	<	<	<	1.1	<	<	<

Table B-6 - Analytical Results – Metals
Lockheed Shipyard No. 1 Sediments Operable Unit (LSSOU)
Harbor Island, Seattle, Washington

Sample Location	Sample ID	Date	Arsenic	Copper	Mercury	Lead	Zinc
SED – 1	12225010007	8/15/2006	8	48.3	0.29	31	75.1
	12225010020	8/30/2007	8	40.3	0.23	18	75
	12225010021	8/30/2007 TL	13	65.6	0.38	44	108
	12225010050	8/5/2008	6 U	42.0	0.25	23	60
	12225010060	8/5/2009	9	45.7	0.16	23	69
	12225010112	8/10/2010	5 U	20.5	0.02	6	28
	12225010111	8/10/2010 TL	11	79.1	0.33	41	116
	12225010206	7/2/2012	9 U	86.3	0.15	45	137
	12225010221	6/13/2014	6	43.8 J	0.09	19	64
SED – 2	12225010008	8/15/2006	10.0	59.6	0.4	38.0	114.0
	12225010022	8/30/2007	8	74.5	**0.74**	44	109
	12225010023	8/30/2007 TL	9	65.5	0.33	43	98
	12225010051	8/5/2008	12	78.4	0.24	61	108
	12225010061	8/5/2009	10	54.2	0.25	26	79
	12225010113	8/10/2010	9	68.3	0.33	38	127
	12225010208	7/2/2012	8 U	76.7	0.31	43	130
	12225010223	6/13/2014	10	64.8 J	**0.50**	35	140
SED – 3	12225010009	8/15/2006	9.0	61.0	0.4	41.0	88.4
	12225010024	8/30/2007	10	62.4	0.32	37	93
	12225010025	8/30/2007 TL	11	66.7	0.4	42	100
	12225010052	8/5/2008	7	43.0	0.19	38	69
	12225010053	8/5/2008 TL	9	62.6	0.36	44	88
	12225010062	8/5/2009	11	68.2	0.30	38	96
	12225010115	8/10/2010	5 U	23.1	0.02 U	5	26
	12225010114	8/10/2010 TL	8	73.8	0.35	41	105
	12225010210	7/2/2012	8 U	55.7	0.29	30	111
	12225010211	7/2/2012 TL	8 U	68.3	0.40	35	105
	12225010225	6/13/2014	7 U	50.5 J	**0.79**	27	78
SED – 4	12225010010	8/15/2006	14	50.1	0.3	54.0	130.0
	12225010026	8/30/2007	14	47.3	0.28	45	105
	12225010054	8/5/2008	7	24.7	0.12	24	78
	12225010063	8/5/2009	11	51.7	0.22	45	97
	12225010116	8/10/2010	9	59.4	0.19	29	114
	12225010212	7/2/2012	7 U	42.7	0.21	29	85
	12225010227	6/13/2014	8	44.3 J	0.33	28	96
SED – 5	12225010011	8/15/2006	10	40.9	0.05 U	11	92
	12225010027	8/30/2007	14	13.7	0.07	15	81
	12225010056	8/5/2008	16	111	0.11	130	214
	12225010064	8/5/2009	6	15.7	0.03	11	41
	12225010117	8/10/2010	8	29.3	0.06	21	112
	12225010214	7/2/2012	15	45.4	0.12	34	136
	12225010229	6/13/2014	6	32.6 J	0.30	26	64

Sample Location	Sample ID	Date	Arsenic	Copper	Mercury	Lead	Zinc
BA – 1	12225010001	8/8/2006	5 U	16.3	0.04 U	3	31.6
	12225010028	8/31/2007	5 U	5.1	0.04 U	2 U	10
	12225010057	8/5/2008	5 U	19.3	0.04 U	3	36
	12225010066	8/6/2009	5 U	9.9	0.02 U	2 U	17
	12225010118	8/11/2010	5 U	12.3	0.02 U	2 U	25
	12225010200	7/2/2012	5 U	15.6	0.02 U	2 U	34
	12225010215	6/13/2014	5 U	21.9 J	0.05 U	2 J	32
BA - 2	12225010002	8/8/2006	5 U	15.2	0.04 U	2	33.4
	12225010029	8/31/2007	5 U	5.5	0.04 U	2 U	19
	12225010058	8/5/2008	5 U	18.1	0.04 U	3	36
	12225010067	8/6/2009	5 U	15.4	0.02 U	3	30
	12225010119	8/11/2010	5 U	14.0	0.03	2	29
	12225010201	7/2/2012	6 U	25.1	0.03 J	5	42
	12225010216	6/13/2014	6 U	26.3 J	0.05 U	5	34
BA - 3	12225010003	8/8/2006	5 U	9.9	0.04 U	2 U	19.3
	12225010030	8/31/2007	6 U	17.3	0.04 U	4	36
	12225010059	8/5/2008	5 U	16.2	0.05 U	5	41
	12225010069	8/6/2009	6 U	19.9	0.04	6	37
	12225010120	8/11/2010	6 U	22.1	0.05	8	48
	12225010203	7/2/2012	7 U	25.3	0.09	10	50
	12225010218	6/13/2014	8	24.8 J	0.08	9	51
BA - 4	12225010004	8/8/2006	5 U	22.5	0.05 U	4	37.8
	12225010032	8/31/2007	5 U	29.0	0.04 U	3	46
	12225010060	8/5/2008	5 U	25.4	0.04 U	4	42
	12225010068	8/6/2009	5 U	5.3	0.02 U	2 U	11
	12225010121	8/11/2010	10 U	29.4	0.02 U	6	59
	12225010204	7/2/2012	5 U	17.2	0.03	8	40
	12225010219	6/13/2014	5 U	11.6 J	0.05 U	2	24
BA - 5	12225010005	8/8/2006	5 U	13.5	0.04 U	2	32.3
	12225010031	8/31/2007	5 U	20.9	0.04 U	4	33
	12225010061	8/5/2008	10	16.0	0.05 U	3	29
	12225010070	8/6/2009	5 U	16.6	0.02 U	3	34
	12225010122	8/11/2010	5 U	15.8	0.02 U	3	37
	12225010205	7/2/2012	6 U	23.1	0.10	21	41
	12225010220	6/13/2014	5 U	9.2 J	0.05 U	5	31
Screening Levels	SQS	mg/kg	57	390	0.41	450	410

SQS= Sediment Quality Standard
TL= Top Layer Sample
mg/kg= Milligrams per kilogram
U= Undetected at the detection limit shown
J= The data was qualified as an estimated value
bold= Compliance sample exceeds SQS

Table B-7 - Analytical Results – Low-molecular Weight Polycyclic Aromatic Hydrocarbons (LPAHs)
Lockheed Shipyard No. 1 Sediments Operable Unit (LSSOU)
Harbor Island, Seattle, Washington

Sample Location	Sample ID	Date	TOC (%)	LPAH	2-Methyl-naphthalen	Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene
SED - 1	12225010007	8/15/2006	0.704	*25*	*9.1 U*	*9.1 U*	*9.1 U*	*9.4*	*9.1 U*	*9.1 U*	*15.6*
	12225010020	8/30/2007	0.888	*7.3*	*7.3 U*	*7.3 U*	*7.3 U*	*7.3*	*7.3 U*	*7.3 U*	*7.3*
	12225010021	8/30/2007 TL	1.42	*11.1*	*4.5 U*	*4.5 U*	*4.5 U*	*4.7*	*4.5 U*	*4.5*	*6.3*
	12225010050	8/5/2008	1.75	*6*	*3.4 U*	*3.4 U*	*3.4 U*	*2.5 J*	*3.4 U*	*3.4 U*	*3.5*
	12225010060	8/5/2009	0.976	*8.2*	*2 U*	*2 U*	*2 U*	*2.6*	*2 U*	*2 U*	*5.6*
	12225010112	8/10/2010	0.220	0.013	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.013 J
	12225010111	8/10/2010 TL	1.72	*8.8*	*1.2 U*	*1.2 U*	*1.2 U*	*2.3*	*0.7 J*	*1.2 U*	*5.8*
	12225010206	7/2/2012	1.78	*18.6*	*1.2*	*1 J*	*1 J*	*4.2*	*1.3*	*2.6*	*7.3*
	12225010221	6/13/2014	0.842	*25*	*1.3 J*	*1.3 J*	*1.3 J*	*4.7*	*1.7 J*	*3.2*	*9.8*
SED - 2	12225010008	8/15/2006	0.908	*30.8*	*7.3 U*	*7.3 U*	*7.3 U*	*9.3*	*7.3 U*	*7.3*	*14.3*
	12225010022	8/30/2007	1.3	*20.1*	*5.1 U*	*5.1 U*	*5.1 U*	*6.2*	*5.1 U*	*5.1 U*	*13.8*
	12225010023	8/30/2007 TL	1.17	*8.5*	*5.3 U*	*5.3 U*	*5.3 U*	*5.3*	*5.3 U*	*5.3 U*	*8.5*
	12225010051	8/5/2008	1.62	*14.1*	*3.6 U*	*3.6 U*	*3.6 U*	*5.4*	*3.6 U*	*3.6 U*	*8.6*
	12225010061	8/5/2009	1.55	*9.4*	*1.2 U*	*0.7 J*	*0.7 J*	*2.4*	*1 J*	*1.2 U*	*5.3*
	12225010113	8/10/2010	1.55	*12.4*	*1.3 U*	*1.3 U*	*1.3 U*	*4.1*	*1 J*	*1.3 U*	*6.2*
	12225010208	7/2/2012	1.75	*16.3*	*0.7 J*	*0.9 J*	*0.9 J*	*3.2*	*1.2*	*2.1*	*7.4*
	12225010223	6/13/2014	1.190	*30*	*2.1*	*1.6*	*1.6*	*5.8*	*2*	*5.5*	*10.9*
SED - 3	12225010009	8/15/2006	0.905	*25.3*	*7 U*	*7 U*	*7 U*	*9.8*	*7 U*	*7 U*	*15.5*
	12225010024	8/30/2007	1.37	*7.3 U*	*4.5 U*	*4.5 U*	*4.5 U*	*4.5 U*	*4.5 U*	*4.5 U*	*7.3 U*
	12225010025	8/30/2007 TL	0.654	*39 U*	*10.2 U*	*10.2 U*	*10.2 U*	*13 U*	*10.2 U*	*10.2 U*	*26 U*
	12225010052	8/5/2008	1.59	*5.5*	*3.6 U*	*3.6 U*	*3.6 U*	*2.4 J*	*3.6 U*	*3.6 U*	*3.1 J*
	12225010053	8/5/2008 TL	1.33	*14.1*	*4.4 U*	*4.4 U*	*4.4 U*	*5.9*	*4.4 U*	*4.4 U*	*8.3*
	12225010062	8/5/2009	1.76	*7.9*	*1.1 U*	*1.1 U*	*1.1 U*	*2.5*	*0.8 J*	*1.1 U*	*4.6*
	12225010115	8/10/2010	0.253	0.011	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.011 J
	12225010114	8/10/2010 TL	1.46	*17.47*	*4 U*	*4 U*	*4 U*	*5.1*	*4 U*	*4 U*	*12.3*
	12225010210	7/2/2012	1.31	*23.8*	*1.5 J*	*1.5*	*1.5*	*4*	*1.7*	*4.1*	*9.9*
	12225010211	7/2/2012 TL	1.51	*17.6*	*1.1 J*	*1.2 J*	*1.2 J*	*3.1*	*1.3*	*3.2*	*6.6*
	12225010225	6/13/2014	1.050	*34.1*	*2.2*	*2.1*	*2.1*	*4.6*	*2.1*	*7.5*	*11.4*

Sample Location	Sample ID	Date	TOC (%)	LPAH	2-Methyl-naphthalen	Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene
SED - 4	12225010010	8/15/2006	0.801	*28*	*8.2 U*	*8.2 U*	*8.2 U*	*9.2*	*8.2 U*	*8.2 U*	*18.7*
	12225010026	8/30/2007	1.03	*9.7 U*	*6.2 U*	*6.2 U*	*6.2 U*	*6.2 U*	*6.2 U*	*6.2 U*	*9.7 U*
	12225010054	8/5/2008	0.707	*10*	*2.8 U*	*2.8 U*	*2.8 U*	*3.7*	*2.8 U*	*2.8 U*	*6.4*
	12225010063	8/5/2009	1.25	*8.2*	*1.6 U*	*1.6 U*	*1.6 U*	*2.1*	*1.6 U*	*1.6 U*	*6.1*
	12225010116	8/10/2010	1.18	*13.6*	*1.6 U*	*1.6 U*	*1.6 U*	*3.8*	*1 J*	*1.1 J*	*6.6*
	12225010212	7/2/2012	1.33	*14.2*	*1 J*	*0.8 J*	*0.8 J*	*2.4*	*1.1 J*	*3.1*	*5.8*
	12225010227	6/13/2014	0.953	*31.9*	*2.3*	*1.6 J*	*1.6 J*	*5.1*	*1.8 J*	*5.8*	*11.5*
SED - 5	12225010011	8/15/2006	0.07	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U
	12225010027	8/30/2007	1.01	*6.5 U*	*6.5 U*	*6.5 U*	*6.5 U*	*6.5 U*	*6.5 U*	*6.5 U*	*6.5 U*
	12225010056	8/5/2008	0.31	0.012	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.012 J
	12225010064	8/5/2009	0.239	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010117	8/10/2010	0.124	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010214	7/2/2012	1.17	*14.9*	*1.6 U*	*0.9 J*	*0.9 J*	*2.7*	*1.2 J*	*3.5*	*6.6*
	12225010229	6/13/2014	0.708	*18.1*	*2.8 U*	*2.8 U*	*2.8 U*	*4.2*	*1.5 J*	*4.8*	*7.6*
BA - 1	12225010001	8/8/2006	0.101	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010028	8/31/2007	0.124	0.059 U	0.059 U	0.059 U	0.059 U	0.059 U	0.059 U	0.059 U	0.059 U
	12225010057	8/5/2008	0.139	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010066	8/6/2009	0.101	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010118	8/11/2010	0.082	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010200	7/2/2012	0.150	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010215	6/13/2014	0.233	*0.097*	*0.02 U*	*0.02 U*	*0.02 U*	*0.02 U*	*0.02 U*	*0.02 U*	*0.097*
BA - 2	12225010002	8/8/2006	0.09	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010029	8/31/2007	0.139	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U
	12225010058	8/5/2008	0.441	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010067	8/6/2009	0.374	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010119	8/11/2010	0.279	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010201	7/2/2012	0.617	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*
	12225010216	6/13/2014	1.140	*5.1*	*1.7 U*	*1.7 U*	*1.7 U*	*2.2*	*1.7 U*	*1.7 U*	*1.7*
	12225010003	8/8/2006	0.200 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010030	8/31/2007	0.078	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U
	12225010059	8/5/2008	0.609	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*

Sample Location	Sample ID	Date	TOC (%)	LPAH	2-Methyl-naphthalen	Acenaphthene	Acenaphthylene	Anthracene	Fluorene	Naphthalene	Phenanthrene
BA - 3	12225010069	8/6/2009	0.896	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*
	12225010120	8/11/2010	0.792	*7.3 U*	*7.3 U*	*7.3 U*	*7.3 U*	*7.3 U*	*7.3 U*	*7.3 U*	*7.3 U*
	12225010203	7/2/2012	0.931	*4*	*2 U*	*2 U*	*2 U*	*2 U*	*2 U*	*2 U*	*4*
	12225010218	6/13/2014	1.060	*1.6 J*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*1.6 J*
BA - 4	12225010004	8/8/2006	0.231	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010032	8/31/2007	0.362	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
	12225010060	8/5/2008	0.381	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010068	8/6/2009	0.357	0.036	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.036
	12225010121	8/11/2010	0.373	0.014	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.014 J
	12225010204	7/2/2012	0.236	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
	12225010219	6/13/2014	0.174	*0.019 U*	*0.019 U*	*0.019 U*	*0.019 U*	*0.019 U*	*0.019 U*	*0.019 U*	*0.019 U*
BA - 5	12225010005	8/8/2006	0.061	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010031	8/31/2007	0.114	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
	12225010061	8/5/2008	0.122	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010070	8/6/2009	0.212	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010122	8/11/2010	0.204	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010205	7/2/2012	0.149	0.016 J	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.016 J
	12225010220	6/13/2014	0.407	0.011 J	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.011 J
Screening Levels	SQS	mg/kg-OC	---	370	38	16	66	220	23	99	100
	LAET	mg/kg		5.20	0.67	0.50	1.3	0.96	0.54	2.1	1.5

LPAH= Low molecular weight polycyclic aromatic hydrocarbon
SQS= Sediment Quality Standard
TOC= Total organic carbon
TL= Top layer
mg/kg-OC= Milligrams of chemical per kilogram of organic carbon (*Italicized Values Reported in mg/kg-OC*)
J= The result is an estimated concentration
U= Undetected at the detection limit shown
LAET= Lowest apparent effects threshold (LAET used for comparison when TOC is less than 0.5 mg/kg)
bold= Compliance sample exceeds SQS and/or LAET

Table B-8 - Analytical Results – High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAHs)

Lockheed Shipyard No. 1 Sediments Operable Unit (LSSOU)

Harbor Island, Seattle, Washington

Sample Location	Sample ID	Date	TOC (%)	HPAH	Benzo(a)-anthracene	Benzo(a)-pyrene	Total Benzo-fluoranthenes	Benzo(g,h,i)-perylene	Chrysene	Dibenz (a,h)-anthracene	Fluor-anthene	Indeno (1,2,3-cd)-pyrene	Pyrene
SED - 1	12225010007	8/15/2006	0.704	251.4	28.4	28.4	62.5	12.5	32.7	9.1 U	39.8	13.1	34.1
	12225010020	8/30/2007	0.888	88.2	8.2	10.1	25.9	7.3	14.6	7.3 U	16.9	7.3	12.4
	12225010021	8/30/2007 TL	1.42	102.8	9.2	10.6	23.9	5.6	15.5	4.5 U	19.0	5.0	14.1
	12225010050	8/5/2008	1.75	50.5	4.7	1.7	3.9	0.8 J	8.0	3.4 U	9.1	3.4	2.0
	12225010060	8/5/2009	0.976	84.1	7	9	20.1	4.7	12.3	2	12.3	4.4	12.3
	12225010112	8/10/2010	0.220	0.172	0.013 J	0.019 J	0.046	0.012 J	0.023	0.02 U	0.021	0.011	0.027
	12225010111	8/10/2010 TL	1.72	57.8	5.2	5.6	12.2	3.1	9.3	1.6	9.9	2.8	8.1
	12225010206	7/2/2012	1.78	107.1	8.4	11.2	25.3	6.7	15.2	2.1	14.6	6.2	17.4
	12225010221	6/13/2014	0.842	132.2	9.6	14.2	33.2	8.2	16.6	2.4	17.8	7.6	22.6
SED - 2	12225010008	8/15/2006	0.908	223.6	17.6	23.1	50.7	12.1	25.3	7.3 U	35.2	11.0	48.5
	12225010022	8/30/2007	1.3	145.2	10	14.6	32.3	6.5	16.2	5.1 U	20.8	6.4	38.5
	12225010023	8/30/2007 TL	1.17	142.1	12	14.5	30.8	6.8	19.7	5.3 U	27.4	6.2	24.8
	12225010051	8/5/2008	1.62	140.1	12.3	17.9	39.5	8.6	20.4	3.6 U	21.6	8.6	19.8
	12225010061	8/5/2009	1.55	77.9	6.5	7.7	16.1	3.7	12.3	1.6	13.5	3.5	12.9
	12225010113	8/10/2010	1.55	99.1	9	11	23.9	5	14.8	2.8	13.5	4.9	14.2
	12225010208	7/2/2012	1.75	95.9	7.4	9.1	20.6	5.7	15.4	1.8	14.9	5.0	16.0
	12225010223	6/13/2014	1.190	147.6	11.8	16.8	37.0	10.1	18.5	2.6	16.8	8.4	24.4
SED - 3	12225010009	8/15/2006	0.905	234.8	19.9	23.2	53.0	10.9	34.3	7 U	39.8	9.5	44.2
	12225010024	8/30/2007	1.37	107.9 U	9.5 U	11.7 U	25.5 U	4.9 U	14.6 U	4.5 U	18.2 U	4.5	19 U
	12225010025	8/30/2007 TL	0.654	373.1 U	32.1 U	42.8 U	90.2 U	15.3 U	48.9 U	10.2 U	61.2 U	15.3	67.3 U
	12225010052	8/5/2008	1.59	37.9	3.5 J	4.6	11.1	3.6 U	5.9	3.6 U	7.5	3.6	5.2
	12225010053	8/5/2008 TL	1.33	116.1	9.8	12	29.3	3.2 J	17.3	4.4 U	26.3	3.1	15.0
	12225010062	8/5/2009	1.76	75.2	6.8	8.5	19.3	3.3	10.8	1.6	10.2	3.3	11.4
	12225010115	8/10/2010	0.253	0.128	0.012 J	0.016 J	0.037	0.02 U	0.019 J	0.02 U	0.020	0.020	0.024
	12225010114	8/10/2010 TL	1.46	161.4	12.3	15.1	34.9	6.8	23.3	3.8 J	32.9	6.8	25.3
	12225010210	7/2/2012	1.31	115.1	9.2	11.5	25.2	7.3	16.8	2.2	16.8	6.3	19.8
	12225010211	7/2/2012 TL	1.51	94.4	7.3	9.9	22.5	6.2	12.6	1.9	12.6	5.5	15.9
	12225010225	6/13/2014	1.050	134.3	10.5	15.2	30.5	8.5	16.2	2.4	18.1	7.5	23.8
	12225010010	8/15/2006	0.801	246.6	21.2	23.7	56.2	11.9	32.5	8.2 U	36.2	11.2	53.7

Sample Location	Sample ID	Date	TOC (%)	HPAH	Benzo(a)-anthracene	Benzo(a)-pyrene	Total Benzo-fluoranthenes	Benzo(g,h,i)-perylene	Chrysene	Dibenz (a,h)-anthracene	Fluor-anthene	Indeno (1,2,3-cd)-pyrene	Pyrene
SED - 4	12225010026	8/30/2007	1.03	107.8 U	9.7 U	10.7 U	26.2 U	6.2 U	14.6 U	6.2 U	21.4 U	6.2	25.2 U
	12225010054	8/5/2008	0.71	61.8	4.8	6.2	14.7	2.8 U	8.3	2.8 U	17.0	2.8	10.7
	12225010063	8/5/2009	1.25	73.4	5.5	7.8	17.6	2.9	9.6	1.4 J	11.2	3.0	14.4
	12225010116	8/10/2010	1.18	108.3	8.4	11.9	26.3	4.8	23.7	2.3	11.0	4.7	15.3
	12225010212	7/2/2012	1.33	71.7	5.6	7.2	15.8	4.5	9.0	1.7	10.5	3.9	13.5
	12225010227	6/13/2014	0.953	136.9	10.4	14.7	31.5	8.1	18.9	2.4	18.9	7.0	23.1
SED - 5	12225010011	8/15/2006	0.07	66 U	66 U	66 U	66 U	66 U	66 U	66	66 U	66 U	66 U
	12225010027	8/30/2007	1.01	6.5 U	6.5 U	6.5 U	6.5 U	6.5 U	6.5 U	6.5	6.5 U	6.5 U	6.5 U
	12225010056	8/5/2008	0.31	0.185	0.012 J	0.021	0.049	0.02 U	0.015 J	0.020	0.02 U	0.02 U	0.043
	12225010064	8/5/2009	0.239	0.016	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020	0.02 U	0.02 U	0.016 J
	12225010117	8/10/2010	0.124	0.088	0.02 U	0.01 J	0.026	0.02 U	0.02 U	0.020	0.02 U	0.02 U	0.042
	12225010214	7/2/2012	1.17	58.5	4.8	6.2	12.8	3.8	7.1	1.4	1.4 J	3.6	10.3
	12225010229	6/13/2014	0.708	108.3	9.5	12.7	25.4	6.2	13	2.8	2.8 U	6.2	19.8
BA - 1	12225010001	8/8/2006	0.101	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020	0.02 U	0.02 U	0.020 U
	12225010028	8/31/2007	0.124	0.059 U	0.059 U	0.059 U	0.059 U	0.059 U	0.059 U	0.059	0.059 U	0.059 U	0.059 U
	12225010057	8/5/2008	0.139	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019	0.019 U	0.019 U	0.019 U
	12225010066	8/6/2009	0.101	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020	0.02 U	0.02 U	0.020 U
	12225010118	8/11/2010	0.082	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019	0.019 U	0.019 U	0.019 U
	12225010200	7/2/2012	0.150	0.019 U	0.019 U	0.019 U	0.037 U	0.019 U	0.019 U	0.019	0.019 U	0.019 U	0.019 U
	12225010215	6/13/2014	0.233	0.59	0.015 J	0.016 J	0.077 J	0.013 J	0.096 J	0.0	0.02 U	0.011 J	0.140 J
BA - 2	12225010002	8/8/2006	0.09	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019	0.019 U	0.019 U	0.019 U
	12225010029	8/31/2007	0.139	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066 U	0.066	0.066 U	0.066 U	0.066 U
	12225010058	8/5/2008	0.441	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020	0.02 U	0.02 U	0.020 U
	12225010067	8/6/2009	0.374	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019	0.019 U	0.019 U	0.019 U
	12225010119	8/11/2010	0.279	0.166	0.01 J	0.021	0.041	0.018 J	0.019 J	0.02	0.02 U	0.014 J	0.020
	12225010201	7/2/2012	0.617	11.2	3.1 U	3.1 UJ	3.6 J	3.1 UJ	2.8 J	3.1	3.1 U	3.1 U	2.4 J
	12225010217	6/13/2014	1.140	45.9	2.8	6.6	10.5	6.7	5.9	1.4	1.4 J	6.2	2.8
BA - 3	12225010003	8/8/2006	0.2	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.020	0.02 U	0.02 U	0.020 U
	12225010030	8/31/2007	0.078	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	0.062 U	0.062	0.062 U	0.062 U	0.062 U
	12225010059	8/5/2008	0.609	6.7	3.1 U	3.1 U	3.1 U	3.1 U	2 J	3.1	3.1 U	3.1 U	2.0 J
	12225010069	8/6/2009	0.896	10.3	2.2 U	2.2 U	3 J	2.2 U	2.3	2.2	2.2 U	2.2 U	2.1 J
	12225010120	8/11/2010	0.792	4.5	7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.3	7.3 U	7.3 U	7.3 U

Sample Location	Sample ID	Date	TOC (%)	HPAH	Benzo(a)-anthracene	Benzo(a)-pyrene	Total Benzo-fluoranthenes	Benzo(g,h,i)-perylene	Chrysene	Dibenz (a,h)-anthracene	Fluor-anthene	Indeno (1,2,3-cd)-pyrene	Pyrene
	12225010203	7/2/2012	0.931	*43.1*	*2.7*	*2.9*	*8.6*	*2.8*	*6.1*	*1.0*	*1 J*	*2.4*	*7.7*
	12225010218	6/13/2014	1.060	*22.7*	*1.9*	*2.2*	*5.7*	*1.9*	*2.8*	*1.9*	*1.9 U*	*1.5 J*	*3.1*
BA - 4	12225010004	8/8/2006	0.231	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010032	8/31/2007	0.362	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
	12225010060	8/5/2008	0.381	0.014	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.014 J	0.019 U	0.019 U
	12225010068	8/6/2009	0.357	0.125	0.020 U	0.020 U	0.022 J	0.020 U	0.017 J	0.020 U	0.052	0.020 U	0.034
	12225010121	8/11/2010	0.373	0.178	0.014 J	0.014 J	0.043	0.010 J	0.030	0.019 U	0.038	0.019 U	0.029
	12225010204	7/2/2012	0.236	0.039 U	0.020 U	0.020 U	0.039 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010219	6/13/2014	0.174	0.038 U	0.019 U	0.019 U	0.038 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
BA - 5	12225010005	8/8/2006	0.061	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010031	8/31/2007	0.114	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U
	12225010061	8/5/2008	0.122	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010070	8/6/2009	0.212	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010122	8/11/2010	0.204	0.039 U	0.020 U	0.020 U	0.039 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010205	7/2/2012	0.149	0.259	0.019	0.021	0.048	0.014 J	0.053	0.019 U	0.046	0.012 J	0.046
	12225010220	6/13/2014	0.407	0.119	0.020 U	0.014 J	0.031 J	0.020 U	0.018 J	0.020 U	0.020	0.020 U	0.018 J
Screening Levels	SQS	mg/kg-OC	---	960	110	99	230	31	110	12	12	34	1,000
	LAET	mg/kg	---	12	1.3	1.6	3.2	0.67	1.4	0.23	0.23	0.69	2.6

HPAH= High molecular weight polycyclic aromatic hydrocarbon
SQS= Sediment Quality Standard
TOC= Total organic carbon
TL= Top layer
mg/kg-OC= Milligrams of chemical per kilogram of organic carbon (*Italicized Values Reported in mg/kg-OC*)
J= The result is an estimated concentration
U= Undetected at the detection limit shown
UJ= Indicated the compound was analyzed for but not detected. The sample detected limit is an estimated value.
LAET= Lowest apparent effects threshold (LAET used for comparison when TOC is less than 0.5 mg/kg)
bold= Compliance sample exceeds SQS and/or LAET

Table B-9 - Analytical Results - Polychlorinated Biphenyls (PCBs)
Lockheed Shipyard No. 1 Sediments Operable Unit (LSSOU)
Harbor Island, Seattle, Washington

Sample Location	Sample ID	Date	TOC %	Total PCBs	PCBs (mg/kg)						
					Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
	12225010007	8/15/2006	0.704	*3.1*	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*	*3.1*	*2.8 U*
	12225010020	8/30/2007	0.888	*2.5*	*2.3 U*	*2.3 U*	*2.3 U*	*2.3 U*	*2.3U*	*2.5*	*2.3U*
	12225010021	8/30/2007 TL	1.42	*6.1*	*1.4 U*	*1.4 U*	*1.4 U*	*1.4 U*	*1.4 U*	*3.5*	*2.7*
	12225010050	8/5/2008	1.75	*1.7*	*1.1 U*	*1.1 U*	*1.1 U*	*1.1 U*	*1.1 U*	*1.7*	*1.1 U*
SED - 1	12225010060	8/5/2009	0.976	*2.2*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*2.2*	*1.9 U*
	12225010112	8/10/2010	0.220	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010111	8/10/2010 TL	1.72	*5.6*	*1.2 U*	*1.2 U*	*1.2 U*	*1.2 U*	*1.7*	*2.5*	*1.4*
	12225010206	7/2/2012	1.78	*11.1*	*5.3 U*	*5.3 U*	*5.3 U*	*5.3 U*	*5.3 U*	*6.2*	*4.9 J*
	12225010221	6/13/2014	0.842	*11.6*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 UJ*	*2.6 J*	*5.9*	*3.1 J*
	12225010008	8/15/2006	0.908	*8.5*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*	*3.7*	*4.7*
	12225010022	8/30/2007	1.3	*8.2*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*3.8*	*4.5*
	12225010023	8/30/2007 TL	1.17	*8.9*	*1.7 U*	*1.7 U*	*1.7 U*	*1.7 U*	*1.7 U*	*4.6*	*4.3*
SED - 2	12225010051	8/5/2008	1.62	*4.1*	*1.2 U*	*1.2 U*	*1.2 U*	*1.2 U*	*1.2 U*	*2.6*	*1.5*
	12225010061	8/5/2009	1.55	*1.5*	*1.3 U*	*1.3 U*	*1.3 U*	*1.3 U*	*1.3 U*	*1.5*	*1.3 U*
	12225010113	8/10/2010	1.55	*5.68*	*1.3 U*	*1.3 U*	*1.3 U*	*1.3 U*	*1.9 U*	*3.55*	*2.13*
	12225010208	7/2/2012	1.75	*11.7*	*5.0 U*	*5.0 U*	*5.0 U*	*5.0 U*	*5.0 U*	*6.9*	*4.8 J*
	12225010223	6/13/2014	1.190	*11.9*	*1.6 U*	*1.6 U*	*1.6 U*	*1.6 UJ*	*2.6*	*6.2 J*	*3.1 J*
	12225010009	8/15/2006	0.905	*9.5*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*	*2.2 U*	*5.4*	*4.1*
	12225010024	8/30/2007	1.37	*8.3*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*4.5*	*3.8*
	12225010025	8/30/2007 TL	0.654	***17.0***	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*9.3*	*7.6*
	12225010052	8/5/2008	1.59	*1.4*	*1.2 U*	*1.2 U*	*1.2 U*	*1.2 U*	*1.2 U*	*1.4*	*1.2 U*
	12225010053	8/5/2008 TL	1.33	*5.3*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*3.1*	*2.2*
SED - 3	12225010062	8/5/2009	1.76	*2.7*	*1.1 U*	*1.1 U*	*1.1 U*	*1.1 U*	*1.1 U*	*1.4*	*1.3*
	12225010115	8/10/2010	0.253	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010114	8/10/2010 TL	1.46	*6.4*	*1.4 U*	*1.4 U*	*1.4 U*	*1.4 U*	*2.0 U*	*3.9*	*2.5*
	12225010210	7/2/2012	1.31	*6.8*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*2.6 U*	*4.4*	*2.4*
	12225010211	7/2/2012 TL	1.51	*11.4*	*5.9 U*	*5.9 U*	*5.9 U*	*5.9 U*	*5.9 U*	*6.6*	*4.8* J
	12225010225	6/13/2014	1.050	***12.4***	*1.6 U*	*1.6 U*	*1.6 U*	*1.6 UJ*	*2.8*	6.6 J	3.0 J
	12225010010	8/15/2006	0.801	*6.4*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*	*2.9*	*3.5*
	12225010026	8/30/2007	1.03	*8.5*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*1.9 U*	*5.2*	*3.3*
	12225010054	8/5/2008	0.707	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*	*2.8 U*
SED - 4	12225010063	8/5/2009	1.25	*1.6*	*1.6 U*	*1.6 U*	*1.6 U*	*1.6 U*	*1.6 U*	*1.6*	*1.6 U*
	12225010116	8/10/2010	1.18	***12.6***	*1.6 U*	*1.6 U*	*1.6 U*	*1.6 U*	*3.2 U*	*4.8*	*7.8*
	12225010212	7/2/2012	1.33	*5.4*	*1.4 U*	*1.4 U*	*1.4 U*	*1.4 U*	*1.9 U*	*3.2*	*2.2*
	12225010227	6/13/2014	0.953	*8.0*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 UJ*	*5.1*	*2.9 J*	*2.1 UJ*
	12225010011	8/15/2006	0.07	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010027	8/30/2007	1.01	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*
	12225010056	8/5/2008	0.310	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
SED - 5	12225010064	8/5/2009	0.239	0.062	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.031	0.031
	12225010117	8/10/2010	0.124	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010214	7/2/2012	1.17	*8.7*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 U*	*3.2 U*	*6.6*	*2.1*
	12225010229	6/13/2014	0.708	*7.1*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 UJ*	*3.1*	*2.0 J*	*1.97 J*
	12225010001	8/8/2006	0.101	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010028	8/31/2007	0.124	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010057	8/5/2008	0.139	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
BA - 1	12225010066	8/6/2009	0.101	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010118	8/11/2010	0.082	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U

Sample Location	Sample ID	Date	TOC %	Total PCBs	PCBs (mg/kg) Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
	12225010200	7/2/2012	0.150	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
	12225010215	6/13/2014	0.233	0.018 U	0.018 U	0.018 U	0.018 U	0.018 UJ	0.018 UJ	0.018 U	0.018 UJ
BA - 2	12225010002	8/8/2006	0.09	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010029	8/31/2007	0.139	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010058	8/5/2008	0.441	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010067	8/6/2009	0.374	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010119	8/11/2010	0.279	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010201	7/2/2012	0.617	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*
	12225010216	6/13/2014	1.140	*1.0 J*	*1.5 U*	*1.5 U*	*1.5 U*	*1.5 UJ*	*1.5 UJ*	*1.0 J*	*1.5 UJ*
BA - 3	12225010003	8/8/2006	0.2	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010030	8/31/2007	0.078	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010059	8/5/2008	0.609	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*	*3.1 U*
	12225010069	8/6/2009	0.896	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*	*2.1 U*
	12225010120	8/11/2010	0.792	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*	*2.5 U*
	12225010203	7/2/2012	0.931	*2.5*	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*	*2.0 U*	*2.5*	*2.0 U*
	12225010218	6/13/2014	1.060	*1.4 J*	*1.6 U*	*1.6 U*	*1.6 U*	*1.6 UJ*	*1.6 UJ*	*1.4 J*	*1.6 UJ*
BA - 4	12225010004	8/8/2006	0.231	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010032	8/31/2007	0.362	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010060	8/5/2008	0.381	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010068	8/6/2009	0.357	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010121	8/11/2010	0.373	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010204	7/2/2012	0.236	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U
	12225010219	6/13/2014	0.174	0.017 U	0.017 U	0.017 U	0.017 U	0.017 UJ	0.017 UJ	0.017 U	0.017 UJ
BA - 5	12225010005	8/8/2006	0.061	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010031	8/31/2007	0.114	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010061	8/5/2008	0.122	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010070	8/6/2009	0.212	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
	12225010122	8/11/2010	0.204	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
	12225010205	7/2/2012	0.149	0.027	0.017 U	0.017 U	0.017 U	0.017 U	0.036 U	0.027	0.017 U
	12225010220	6/13/2014	0.407	0.020 U	0.020 U	0.020 U	0.020 U	0.020 UJ	0.020 UJ	0.020 U	0.020 UJ
Screening Levels	SQS	mg/Kg-OC	---	12	---	---	---	---	---	---	---
	LAET	mg/Kg	---	0.13	---	---	---	---	---	---	---

PCB= Polychlorinated biphenyl

SQS= Sediment Quality Standard

TOC= Total organic carbon

TL= Top layer

mg/kg-OC= Milligrams of chemical per kilogram of organic carbon (*Italicized Values Reported in mg/kg-OC*)

J= The result is an estimated concentration

U= Undetected at the detection limit shown

UJ= Indicated the compound was analyzed for but not detected. The sample detected limit is an estimated value.

LAET= Lowest apparent effects threshold (LAET used for comparison when TOC is less than 0.5 mg/kg)

bold= Compliance sample exceeds SQS and/or LAET

Appendix C: List of Documents Reviewed

Documents Reviewed

Soil & Groundwater - OU1

AECOM, 2012. 2010-2011 Annual Groundwater Monitoring Report – Final. Harbor Island Superfund Site – Soil and Groundwater Operable Unit, Seattle, Washington. February 2012.

AECOM, 2013. 2011-2012 Annual Groundwater Monitoring Report – Final. Harbor Island Superfund Site – Soil and Groundwater Operable Unit, Seattle, Washington. June 2013.

AECOM, 2014. 2012-2013 Annual Groundwater Monitoring Report – Final. Harbor Island Superfund Site – Soil and Groundwater Operable Unit, Seattle, Washington. June 2014.

CDM, 2011. Letter to Ravi Sanga, EPA, Re: Harbor Island Soil and Groundwater Operable Unit Consent Decree Annual Cap Inspections (2010 and 2011): APPR Parcels A and B. April 18, 2011.

EPA, 1993. Record of Decision for Harbor Island Soil and Groundwater, Seattle, Washington. September 1993.

EPA, 1996. Amended Record of Decision, Soil and Groundwater Operable Unit of the Harbor Island Superfund Site, Seattle, Washington. January 1996.

EPA, 2001. Explanation of Significant Differences Number 2 (ESD#2) for the Harbor Island Superfund Site, Soil and Groundwater Operable Unit, Seattle, Washington. August 2001.

EPA, 2013. Letter to Floyd|Snider, re: USEPA Approval – Proposal for Optimizing the LNAPL monitoring network, Todd/Vigor Pacific Shipyard, Soil & Groundwater Operable Unit, Harbor Island Superfund Site, Seattle, Washington. December 13. 2013.

Floyd | Snider, 2012a. Remedial Action Completion Report for Design Set 3. Prepared for Vigor Industrial LLC. September 28, 2012.

Floyd|Snider, 2012b. Cap Inspection and Maintenance Plan. Prepared for Vigor Industrial LLC. November 19, 2012.

Floyd|Snider, 2013. Letter to EPA, re: Proposed LNAPL Monitoring Network Optimization Vigor Shipyards. December 11, 2013.

Floyd|Snider, 2010-2015. Quarterly Progress Reports – LNAPL Recovery System, Todd Pacific Shipyards, Soil and Groundwater Operable Unit, Harbor Island Superfund Site.

King County, 2011. Letter to Ravi Sanga, EPA, Re: 2010 Annual Report of Inspections of Activities Relating to the Remedial Action Cap for King County/Fisher Mills Property on Harbor Island. March 8, 2011.

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King County, 2014. Letter to Ravi Sanga, EPA, Re: 2013 Annual Report of Inspections of Activities Relating to the Remedial Action Cap for King County/Fisher Mills Property on Harbor Island. May 22, 2014.

Tech Solv, 2010. Letter to Ravi Sanga, EPA, Re: Institutional Control Evaluation for Harbor Island Soil and Groundwater Operable Unit, Seattle, Washington. January 29, 2010.

Windward Environmental LLC, 2010. 2010 Terminal 18 Cap Inspection Report, Port of Seattle Terminal 18, Harbor Island. Prepared for Port of Seattle. November 9, 2010.

Windward Environmental LLC, 2012. 2011 Terminal 18 Cap Inspection Report, Port of Seattle Terminal 18, Harbor Island. Prepared for Port of Seattle. February 29, 2012.

Windward Environmental LLC, 2013. 2012 Terminal 18 Cap Inspection Report, Port of Seattle Terminal 18, Harbor Island. Prepared for Port of Seattle. February 8, 2013.

Windward Environmental LLC, 2014. 2013 Terminal 18 Cap Inspection Report, Port of Seattle Terminal 18, Harbor Island. Prepared for Port of Seattle. February 17, 2014.

Windward Environmental LLC, 2015. 2014 Terminal 18 Cap Inspection Report, Port of Seattle Terminal 18, Harbor Island. Prepared for Port of Seattle. March 12, 2015.

Tank Farms – OU2

Department of Ecology (Ecology), 2014a. BP Harbor Island Terminal Periodic Reivew. Publication No. 14-09-213. December 2014.

Ecology, 2014b. Kinder Morgan Liquids Terminals LLC Periodic Reivew. Publication No. 14-09-214. December 2014.

Ecology, 2014c. Shell Oil Harbor Island Terminal Periodic Reivew. Publication No. 14-09-212. December 2014.

Lockheed Uplands – OU3

EPA, 1994. Record of Decision for Lockheed Shipyard Facility, Harbor Island, Seattle, Washington. June 1994.

EPA, 2010. Letter to Mr. Bill Bath, Lockheed Martin Corporation, re: Response to EPA Request for Information, Studies, and Institutional Control Documentation for the Third Harbor Island Superfund 5-Year Review. February 12, 2010.

Floyd|Snider, 2011. Memorandum to Ravi Sango, USEPA, Re: Description of Terminal 10 Underground Storage Tank Removal. August 31, 2011.

Floyd|Snider, 2012. Port of Seattle Terminal 10, Utility Infrastructure Upgrade Project Completion Report. Prepared for Port of Seattle. May 9, 2012.

Tetra Tech, Inc., 2009. Technical Memorandum, Re: Response to EPA Request for Information and Institutional Control Documentation for the Third Harbor Island Superfund 5-Year Review. December 9, 2009.

Tetra Tech, Inc., 2010. 2010 Annual Cap Inspection Report, Lock Shipyard No. 1 – Uplands, Harbor Island, Seattle, Washington. Prepared for Lockheed Martin Corporation. August 2010.

Tetra Tech, Inc., 2012. 2011 Annual Cap Inspection Report, Lock Shipyard No. 1 – Uplands, Harbor Island, Seattle, Washington. Prepared for Lockheed Martin Corporation. January 2012.

Tetra Tech, Inc., 2012. Tidal Study Report, Yard 1 Uplands Operable Unit, Harbor Island, Washington. Prepared for Lockheed Martin Corporation Shared Services. February 2012.

Tetra Tech, Inc. 2012. Former UST Groundwater Investigation Report, Yard 1 Uplands Operable Unit, Harbor Island, Seattle, Washington. July 2012.

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Tetra Tech, 2010-2013. Semi-Annual Groundwater Monitoring Reports, Lockheed Shipyard No. 1 Uplands, Harbor Island, Seattle, Washington.

Tetra Tech, 2014a. April 2014 Semi-Annual Groundwater Monitoring Report, Uplands OU Program Round 37 Monitoring Event, LSSOU Shoreline Program Round 18 Monitoring Event. June 2014.

Tetra Tech, 2014b. October 2014 Semi-Annual Groundwater Monitoring Report, Uplands OU Program Round 38 Monitoring Event, LSSOU Shoreline Program Round 18 Monitoring Event. December 2014.

Lockheed Shipyard Sediments –OU 7

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EPA, 2002. Explanation of Significant Differences, Lockheed Shipyard Sediment Operable Unit, Harbor Island Superfund Site. EPA/ESD/R10-02/031. February 2002.

EPA, 2003. Explanation of Significant Differences to the Harbor Island – Shipyard Sediment Operable Unit, Lockheed Shipyard Sediments, Seattle, Washington. EPA/ESD/R10-011. March 2003.

EPA, 2010. Letter to Mr. Bill Bath, Lockheed Martin Corporation, re: Response to EPA Request for Information, Studies, and Institutional Control Documentation for the Third Harbor Island Superfund 5-Year Review. February 12, 2010.

Port of Seattle, 2013. Terminal 10 Annual Stormwater Report, 2012. April 4, 2013.

Port of Seattle, 2014. Terminal 10 Annual Stormwater Report, 2013. April 7, 2014.

TerraSond, 2010. Topographic and Bathymetric Survey Report, Lockheed Shipyard No. 1 Sediments Operable Unit (LSSOU), Harbor Island Superfund Site, Seattle, WA. June 2010.

Tetra Tech, Inc., 2005. Final Source Control Report and Sampling and Analysis Plan for the Shoreline Monitoring Program, Seattle Yard 1 Property (Uplands OU and LSSOU) Harbor Island, Seattle, Washington. September 2005.

Tetra Tech, Inc., 2006. Final Baseline Groundwater Monitoring Report Shoreline Groundwater Monitoring Program (November 2005/April 2006). November 2006.

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Tetra Tech, 2010-2013. Shoreline Groundwater Monitoring Reports, Seattle Yard 1 Property, Lockheed Shipyard Sediment OU, Harbor Island, Seattle, Washington.

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Tetra Tech, 2014a. April 2014 Semi-Annual Groundwater Monitoring Report, Uplands OU Program Round 37 Monitoring Event, LSSOU Shoreline Program Round 18 Monitoring Event. June 2014.

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TRC, 2011. 2010 Operation, Monitoring and Maintenance Report, Remedial Action for the Lockheed Shipyard No. 1 Sediments Operable Unit (LSSOU) of Harbor Island Superfund Site, Seattle, Washington. January 2011.

West Waterway – OU8

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Todd Shipyard Sediments – OU9

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EPA, 2003. Explanation of Significant Differences to the Harbor Island – Shipyard Sediment Operable Unit, Todd Shipyard Sediments, Seattle, Washington. EPA/ESD/R10-03/010. March 2003.

Floyd|Snider, 2011. Operation, Maintenance, and Monitoring Plan (OMMP) Year 4 Monitoring Report, Todd Pacific Shipyards, Sediment Operable Unit. December 2011.

Appendix D: Interview Forms

Five-Year Review Interview Record			
Site: Lockheed Shipyard Sediments Operable Unit		**EPA ID No:**	

Interview Type: *[e.g. Visit, Teleconference, etc.]*
Location of Visit:
Date: February 18, 2015
Time:

Interviewers

Name Sharon Gelinas	**Title**	**Organization**

Interviewees

Name	**Organization**	**Title**	**Telephone**	**Email**
Bill Bath	Lockheed Martin	Project Manager	720-842-6106	bill.bath@lmco.com

Summary of Conversation

1) What is your overall impression of the project? ***Very good: the ROD-implemented remedies proved to be effective as indicated by very low levels of compounds of concern (COC) detected in monitoring wells.***

2) Is the remedy functioning as expected? How well is the remedy performing? ***Yes, it is functioning as expected. The sediment removal and capping are preventing contact with COCs and minimizing further contaminant migration.***

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? ***Physical and chemical monitoring of the LSSOU cap indicate variable COC concentrations. Newly-deposited sediment on the cap has had intermittent PCB and mercury exceedances, indicating significant contributions from off-site sources. The ground water monitoring data show concentrations that are non-detectable or below regulatory levels in most wells. Only a single organic compound [tetrachloroethene (PCE)], and four metals including zinc, copper, arsenic and nickel have historically been detected in limited monitoring wells at concentrations above associated groundwater screening levels. These metals have been previously reported at similar concentrations above screening levels in samples taken from upstream West Waterway reference stations during construction of the LSSOU sediment cap.***

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities. ***No, there is not a continuous O&M presence on-site. There is no operating treatment system, so "O&M" consists of well maintenance and CAP inspections. Typically, two environmental professionals inspect and maintain the wells and cap during the sampling and inspection events.***

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts. ***No. However, landowner Port of Seattle has performed several property improvements (removal of treated wood, removal of a newly-discovered underground storage tank, improved surface water drainage and surface water treatment, and additional asphalt cover) that have improved conditions at the site.***

6) What are the annual operating costs for your organization's involvement with the site? ***$80,000 to $130,000.***

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details. ***There have been no unexpected O&M difficulties or costs.***

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency. ***Lockheed Martin is currently seeking EPA concurrence to reduce ground water monitoring frequency from semi-annual to annual. EPA suggested, and Lockheed Martin agreed, to combine reporting for two sites (Seattle Yard 1 uplands and LSSOU) into one report, with a small associated cost savings.*** **Recently completed Port of Seattle site improvements (e.g., improved surface water drainage and surface water treatment) has improved ability to sample and inspect existing flush-mounted monitoring wells in the central portion of the site.**

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy? ***No.*** 10) Do you have any comments, suggestions, or recommendations regarding the project? ***No.***
Additional Site-Specific Questions
[If needed]

Five-Year Review Interview Record				
Site: Yard 1 uplands			**EPA ID No:**	

Interview Type: *[e.g. Visit, Teleconference, etc.]*
Location of Visit:
Date: February 18, 2015
Time:

Interviewers		
Name Sharon Gelinas	**Title**	**Organization**

Interviewees				
Name	**Organization**	**Title**	**Telephone**	**Email**
Bill Bath	Lockheed Martin	Project Manager	720-842-6106	bill.bath@lmco.com

Summary of Conversation

1) What is your overall impression of the project? ***Very good: the ROD-implemented remedies proved to be effective as indicated by very low levels of compounds of concern (COC) detected in monitoring wells.***

2) Is the remedy functioning as expected? How well is the remedy performing? ***Yes, it is functioning as expected. The soil removal and capping are preventing contact with COCs and minimizing further contaminant migration.***

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? ***The monitoring data show concentrations that are non-detectable or below regulatory levels in most wells. Only a single organic compound [tetrachloroethene (PCE)], and four metals including zinc, copper, arsenic and nickel have historically been detected in limited monitoring wells at concentration above associated groundwater screening levels. These metals have been previously reported at similar concentrations above screening levels in samples taken from upstream West Waterway reference stations during construction of the LSSOU sediment cap.***

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities. ***No, there is not a continuous O&M presence on-site. There is no operating treatment system, so "O&M" consists of well maintenance and CAP inspections. Typically, two environmental professionals inspect and maintain the wells during the sampling events, and one qualified professional performs the routine CAP inspections.***

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts. ***No. However, landowner Port of Seattle has performed several property improvements (removal of treated wood, removal of a newly-discovered underground storage tank, improved surface water drainage and surface water treatment, and additional asphalt cover) that have improved conditions at the site.***

6) What are the annual operating costs for your organization's involvement with the site? ***$110,000 to 130,000.***

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details. ***There have been no unexpected O&M difficulties. EPA requests for special studies (pore water analysis, tidal studies, Institutional Control study etc.) represent unexpected costs for the site.***

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency. ***Lockheed Martin is currently seeking EPA concurrence to reduce monitoring frequency from semi-annual to annual. EPA suggested, and Lockheed Martin agreed, to combine reporting for two sites (Seattle Yard 1 uplands and LSSOU) into one report, with a small associated cost savings.*** **Recently completed Port of Seattle site improvements (e.g., improved surface water drainage and surface water treatment) has improved ability to sample and inspect existing flush-mounted monitoring wells in the central portion of the site.**

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy? ***No.***

10) Do you have any comments, suggestions, or recommendations regarding the project? ***The October 2015 comprehensive, low-tide sampling event represented the 38th round (19th year) of long-term groundwater monitoring for the Yard 1 Uplands site. Lockheed Martin is planning for transition from semi-annual to annual groundwater monitoring for former Shipyard No.1 on Harbor Island, Washington, including annual sampling during low-tide stages in late Spring.***
Additional Site-Specific Questions
[If needed]

Five-Year Review Interview Record			
Site: Terminal 18/Harbor Island		**EPA ID No:**	

Interview Type: Visit
Location of Visit: Port of Seattle Terminal 18/Harbor Island/Washington
Date: February 4, 2015
Time: 11:45 AM

Interviewers

Name	Title	Organization
Sharon Gelinas	Hydrogeologist	USACE

Interviewees

Name	Organization	Title	Telephone	Email
Brick Spangler	Port of Seattle	Environmental Program Manager	206 787-3193	Spangler.B@portseattle.org
Warren Hansen	Windward Environmental	Port of Seattle Consultant	206 812-5434	warrenH@windwardenv.com

Summary of Conversation

1) What is your overall impression of the project?

Environmental remediation work was completed at Terminal 18 in 2001, which included the installation of concrete or asphalt caps in areas within the terminal Since that time the Port has continuously implemented inspection and maintenance activities and made cap repairs as needed. Overall my impression is the cap and post-remediation features are performing as expected.

2) Is the remedy functioning as expected? How well is the remedy performing?

Yes (see above). The remedy is performing well in large part due to the Port's level of attention given to the maintenance of caps as set forth under the original design plans. The Port routinely works in cooperation with the tenant to communicate and remind personnel of the unique pavement requirements (e.g., no excavation allowed without coordination with the Port).

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

Groundwater monitoring results for Harbor Island, including evaluation of trends, are included in the annual groundwater monitoring reports provided to EPA by the Soil and Groundwater OU group of which the Port is a member.

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

The tenant (SSA) staff are advised of the O&M needs, as well as various limits regarding cap areas (e.g., no excavation) and coordinate with the Port regarding any facility needs that might require penetration of the cap. In addition the Cap is inspected annually (each December) in order to meet ongoing inspection and maintenance obligations.

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts.

Not changes that we are aware of.

6) What are the annual operating costs for your organization's involvement with the site?

Approximately $180,000 to $200,000.

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

No.

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

No

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy?

No.

10) Do you have any comments, suggestions, or recommendations regarding the project?

No.

Additional Site-Specific Questions
[If needed]

Five-Year Review Interview Record			
Site:	*BP West Coast Products Terminal*	**EPA ID No:**	*WAD009590779*

Interview Type: *Site Visit*
Location of Visit: *BP West Coast Products Terminal. 1652 SW Lander Street, Seattle, Washington*
Date: *December 4, 2014*
Time: *13:30-15:00*

Interviewers

Name	Title	Organization
Maura S. O'Brien	*Professional Geologist / Hydrogeologist*	*Toxics Cleanup Program - NWRO Department of Ecology*

Interviewees

Name	Organization	Title	Telephone	Email
Scott Larsen	*TechSolve, Environmental, Inc.*	*Project Manager*	*425-402-8277*	*slarsen@techsolveinc.com*
Matt Roberts	*TechSolve, Environmental, Inc.*	*Staff Scientist*	*425-402-8277*	*mroberts@techsolveinc.com*
Paul Supple	*BP*	*Environmental Business Manager*	*925-275-3801*	*paul.supple@bp.com*

Summary of Conversation

1) What is your overall impression of the project?
The cleanup actions completed at the Site appear to be protective of human health and the environment.

2) Is the remedy functioning as expected?. How well is the remedy performing?
The remedy appears to be functioning as expected and performing as desired based upon review of monitoring and system performance data. Cleanup objectives in most areas of the Site have been met. Data from areas of the Site with remaining contamination show contaminant levels to be stable and decreasing.

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?
Groundwater monitoring data shows contaminant levels mainly below cleanup levels in most wells at the Site. Historically, Waterfront Compliance Monitoring Wells AMW-01 and AMW-02 at Plant 1 were routinely above the benzene cleanup level. However, over the past 5-years benzene concentrations in these wells have decreased markedly and are now mainly below cleanup levels.

An inland gasoline plume along the southern property boundary at Plant 1 historically impacted shallow groundwater. An Inland SVE System has operated since 2008 and has improved groundwater quality in this area of the Site. Gasoline and benzene concentrations are mainly below cleanup levels along the southern property boundary.

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of Site inspections and activities.
There is a continued O&M presence at the Site for a Groundwater/LNAPL recovery system located along the waterfront at Plant 1 and for the Inland SVE System located along the southern property boundary at Plant 1. The Site is continually manned and O&M activities are conducted on both systems weekly at a minimum. Monitoring activities are conducted to ensure continued operation of systems and compliance with associated PSCAA air discharge authorizations and with a KCDNR sanitary sewer discharge permit

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts.
There have been no significant changes in the last five years.

6) What are the annual operating costs for your organization's involvement with the Site?
Total annual O&M, monitoring, reporting, and project management costs are around $500K for the Site.

7) Have there been unexpected O&M difficulties or costs at the Site in the last five years? If so, please give details.
The waterfront Groundwater/LNAPL Recovery System was designed to operate for 5 years, but has operated continuously for over 12 years. Due to the extended system life, materials and equipment have needed to be replaced to keep the system operational. Additionally, the brackish nature of the groundwater is prone to bioufouling, which has required additional O&M to clean and treat wells, pumps, piping, and system treatment components.

The Inland SVE System along the southern property boundary utilizes shallow horizontal wells to recovery vapors. During wetter periods of the year (typically winter and spring) these well screens can become partially to fully submerged by rising groundwater.

The rising groundwater can increase system fouling and/or prevent vapor capture. The system is turned off during these periods and system operation is resumed once groundwater elevations have fallen to a safe level to resume system operation.

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.
Waterfront SVE and air sparging operations were discontinued in 2008 as they were not longer providing hydrocarbon capture or affecting biodegradation.

The Inland SVE System, currently in operation, appears to no longer capture measurable concentrations of hydrocarbons and may no longer be affecting biodegradation. BP may propose discontinuing operation of the Inland SVE system based upon the decreasing benefits provided by continued system operation.

Waterfront Groundwater/LNAPL Recovery System operation will be reevaluated after portions of the seawall have been upgraded. BP is voluntarily upgrading portions of the waterfront seawall at Plant 1 to increase the seismic stability of the Site. Portions of the seawall date to island construction in the early 1900s and have been identified as being seismically vulnerable. BP plans to upgrade the northern seawall in 2015 and may upgrade the southern seawall in a subsequent year. These seawall upgrades will likely change Site hydrology and BP has agreed to perform evaluations following seawall install to determine if modifications to system operations and monitoring are necessary.

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy?
No.

10) Do you have any comments, suggestions, or recommendations regarding the project?
Based on this periodic review, the Department of Ecology has determined that the requirements of the Restrictive Covenant continue to be met. No additional cleanup actions are required by the property owner. It is the property owner's responsibility to continue to inspect the Site to assure that the integrity of the remedy is maintained.

Additional Site-Specific Questions
[If needed]

Five-Year Review Interview Record			
Site:	Kinder Morgan Liquids Terminal Harbor Island	**EPA ID No:**	**WAD980722839**

Interview Type: Site Visit
Location of Visit: Kinder Morgan Liquids Terminal Harbor Island
Date: November 19, 2014
Time: 2:00 pm

Interviewers

Name	Title	Organization
Maura O'Brien	Professional Geologist/Hydrogeologist and Site Manager	Toxics Cleanup Program, NWRO, Department of Ecology

Interviewees

Name	Organization	Title	Telephone	Email
Robert Truedinger	Kinder Morgan Inc.	Remediation Project Manager	(510) 412-8813	robert_truedinger@ kindermorgan.com

Summary of Conversation

1) What is your overall impression of the project?

Significant progress continues to be made on the project and good collaboration occurs between Kinder Morgan and DOE. Kinder Morgan remains committed to the project goals and working with DOE and stakeholders in a productive fashion.

2) Is the remedy functioning as expected? How well is the remedy performing?

The remedy implemented for B and D yards was anaerobic biological oxidation (ABOX) of total petroleum hydrocarbon (TPH) impacts in groundwater through the land application of two reagents, Epsom salt and gypsum. These reagents deliver sulfate to the groundwater system through precipitation (supplemented with irrigation) and infiltration. Sulfate concentrations have been sustained above the threshold of 500 mg/L sulfate for 13 months post- implementation (most recent sampling event). TPH-G and BTEX concentrations in the land application area are all less than baseline collected pre-implementation and continue to exhibit decreasing trends.

3) What does the monitoring data show?

Groundwater analytical results collected from select wells across the site indicate decreasing or stable trends of site constituents of concern, particularly total petroleum hydrocarbons in the gasoline range and benzene. Conditions continue to improve and remain protective of human health and the environment.

Are there any trends that show contaminant levels are decreasing?

Yes

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

The Kinder Morgan Harbor Island Terminal is an active operating terminal facility and the selected remedy is passive (sulfate land application). There are monthly visits by a Kinder Morgan consultant to inspect the functionality and integrity of the existing sulfate irrigation system. This system is entirely automated and only requires maintenance when winterizing or de-winterizing.

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts.

On August 13, 2014, the Washington State Department of Ecology approved a groundwater monitoring frequency reduction request. The decision to reduce groundwater monitoring at the site from a quarterly to a semiannual frequency was based on the stability of groundwater conditions at the site, the lack of off-site migration of groundwater constituents of concern, and the fact that no product releases had occurred at the site since 2010.There have been no significant changes to O&M requirements or maintenance schedules.

6) What are the annual operating costs for your organization's involvement with the site?
$140,000/year.

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

There have not been any unexpected O&M difficulties within the last five years. Submeters were installed after the initial irrigation system construction in order to measure and record the volume of water used for remedial purposes. These volumes are then deducted from the site's sewer discharge bill.

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

Groundwater sampling efforts were optimized by the approved sampling reduction discussed previously. The reduction in sampling frequency from a quarterly to a semiannual basis will results in savings of approximately 40% of the annual groundwater sampling expenditure.

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy?

No.

10) Do you have any comments, suggestions, or recommendations regarding the project?
No.

Additional Site-Specific Questions

Five-Year Review Interview Record			
Site:	Shell Harbor Island	**EPA ID No:**	

Interview Type: Site visit
Location of Visit: 2555 13th Avenue SW, Seattle Washington
Date: 11/4/2014
Time: 14:00-16:00

Interviewers

Name	**Title**	**Organization**
Maura O'Brien	Toxics Cleanup Program	Ecology

Interviewees

Name	**Organization**	**Title**	**Telephone**	**Email**
Paul Katz	Shell	Terminal Manager	206.224.0484	paul.katz@Shell.com
Perry Pineda	Shell	Shell Oil SR. Environmental PM	425.413.1164	Perry.pineda@Shell.com
Brian Pletcher	AECOM	Project Manager	503.243.3120	Brian.pletcher@AECOM.COM

Summary of Conversation

1) What is your overall impression of the project?

2) Is the remedy functioning as expected? How well is the remedy performing?
Remedy is functioning as expect. Natural attenuation of dissolved hydrocarbons is occurring and recommend MNA.

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?
The SH-04 area continues to show a decrease in contaminate levels. The TX-03A area is continues to be evaluated and delineated.

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities. O&M consists of monthly free product removal and monitoring at the Shoreline manifold area.

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts. Current practices at the Shoreline appear to be protective.

6) What are the annual operating costs for your organization's involvement with the site?

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

None

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency. In 2012 quarterly vac events were conducted to reduce free product in wells. Product is not very mobile and product continues to be observed in 2 wells at the Shoreline Manifold area. Vac events were discontinued due to lack of effectiveness.

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy? None

10) Do you have any comments, suggestions, or recommendations regarding the project? Continue MNA, product removal and assessment of TX-03A area.

Additional Site-Specific Questions

[If needed]

Appendix E: Site Inspection Trip Report and Checklist

Trip Report
Harbor Island Superfund Site, Seattle, WA

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1. INTRODUCTION

a. Date of Visit: 04 February 2015

b. Location: Harbor Island Superfund Site, OU1 and OU3

c. Purpose: A site visit was conducted to visually inspect and document the conditions of the remedy, the site, and the surrounding area for inclusion into the Five-Year Review Report.

d. Participants:

Ravi Sanga	EPA, Remedial Project Manager
Sharon Gelinas	USACE, Hydrogeologist
Aaron King	USACE, Environmental Engineer
Brick Spangler	Port of Seattle, Environmental Program Manager
Warren Hansen	Windward Environmental, Consultant
Chad Wiggins	Windward Environmental, Consultant
Kelly Garber	SSA Marine, Environmental Manager
Stephen Bentsen	Floyd|Snider, Consultant
Paul Torrey	Vigor Shipyards, Environmental Manager

2. SUMMARY

The Soil and Groundwater (OU1) and Lockheed Uplands (OU3) operable units were inspected. Typical operations and maintenance, as well as activities since the last five-year review, were discussed. Cap inspections occur regularly at each OU, and appropriate maintenance actions are taken as necessary. Though some standing water, plants, and cracks were observed in some areas during the inspection, the caps are generally in good condition and functioning as intended. LNAPL recovery continues at the West Shed in the Todd Uplands, which is part of OU1. The LNAPL recovery and treatment system appears to be well-maintained, and is in good operating condition.

3. DISCUSSION

The FYR team arrived in a parking lot outside of the gated Port of Seattle property around 11:00 am. The weather was overcast, windy, and cool with occasional light rain. The group loaded into a small bus and began touring the largest portion of the S&G OU1 asphalt cap. The cap is 10 inches thick, and was installed in 2 inch lifts. Operations and maintenance activities for the asphalt cap were discussed. Cap inspections occur annually toward the end of the year. Inspections are performed on foot; areas of standing water, cracks, and plant growth are noted. Shallow standing water was observed at many locations on site, but it is not considered a significant issue unless the water is more than three inches deep. Cracks in the cap were observed in many places, particularly close to manholes and rail lines. Most cracks are in the upper lift and are repaired if they get too thick or if cap material comes loose. The growth of cracks is monitored from inspection to inspection. Limited plant growth was observed in a few places. Monitoring well HI-3 was visited, but not opened; a couple bolts from the well vault were missing. The tour ended at the parking lot outside of the gated Port property, where the group exited the bus.

From the parking lot, the group traveled to LU OU3. As a result of recommendations in the previous five-year review, a new continuous pavement cap, a new stormwater conveyance system, and security fencing had been installed. Minimal water ponding was observed in the area of the new cap; no cracks were observed. The improvements appear to be serving their intended purposes adequately. In other areas, crack repairs with sealant were evident. Vegetation was present in the small cap on the north end of OU3. The cap is inspected annually, and repairs are made as needed.

Finally, Mr. Sanga, Ms. Gelinas, and Mr. King met with current representatives and contractors associated with the former Todd Shipyards uplands, which is also a part of the S&G OU1. The group walked to the West LNAPL shed. Operating LNAPL recovery wells FW-19 and FW-18 were observed along the way. Recovery well FW-18 was opened, and appeared to be in good operating condition. The treatment process equipment in the West LNAPL Shed appeared to be well-maintained and in good operating condition. At the time of the visit, the catalytic oxidizer was off, but it was stated that it would likely be turned back on due to recent higher contaminant concentrations observed in air. The group then walked to the East LNAPL Shed, which was inactive due to lack of LNAPL in the LNAPL recovery wells. The asphalt cap on property was briefly observed, and there did not appear to be any issues.

4. ACTIONS

The USACE will incorporate information obtained from the site visit into the Five Year Review report.

Aaron King	Sharon Gelinas
Environmental Engineer	Hydrogeologist
CENWS-EN-TS-ET	CENWS-EN-TS-GE

Site Visit Photos

Soil and Groundwater OU1

Photo 1. K-rail on the western S&G OU1 cap boundary

Photo 2. Concrete strip on eastern S&G OU1 cap boundary

Photo 3. Capped area – standing water

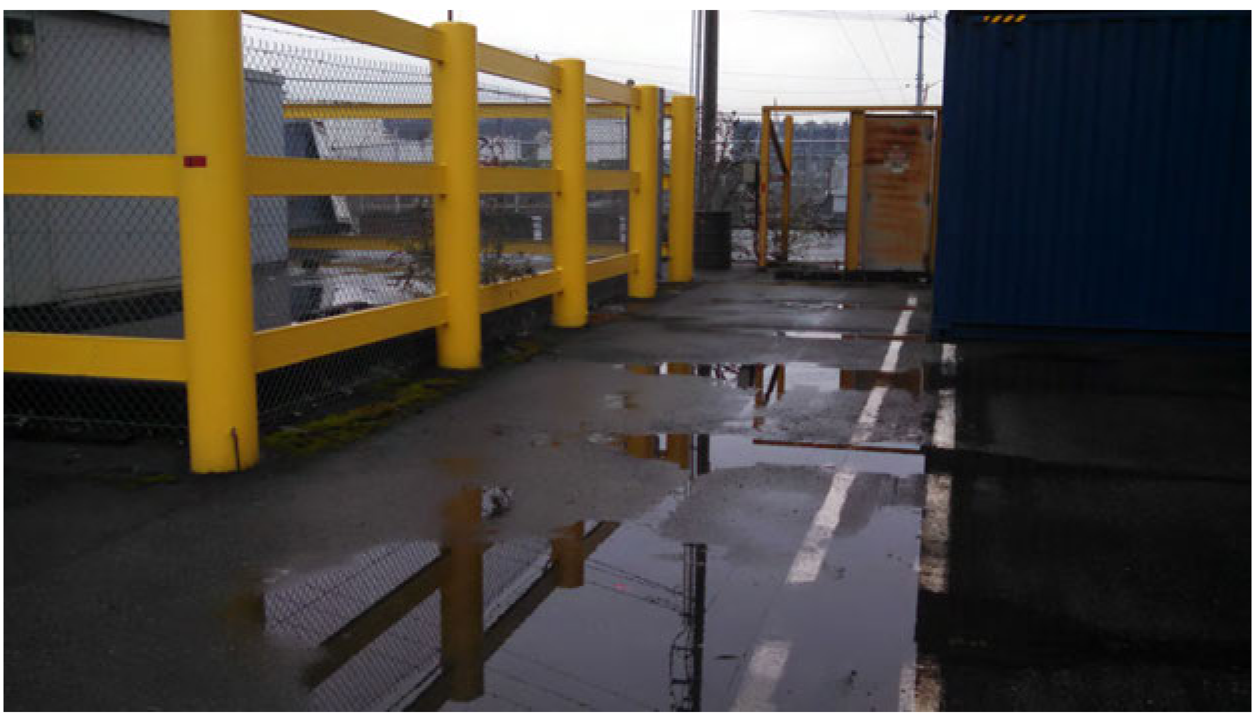

Photo 4. Vegetation growth in capped area

Photo 5. Monitoring well HI-3 (bolts missing)

Lockheed Uplands OU3

Photo 6. Monitoring wells 32S and 32D

Photo 7. Edge of new asphalt cap

Photo 8. Minimal water ponding after regrading and capping

Photo 9. New stormwater outfall

Photo 10. Stormwater treatment access vault

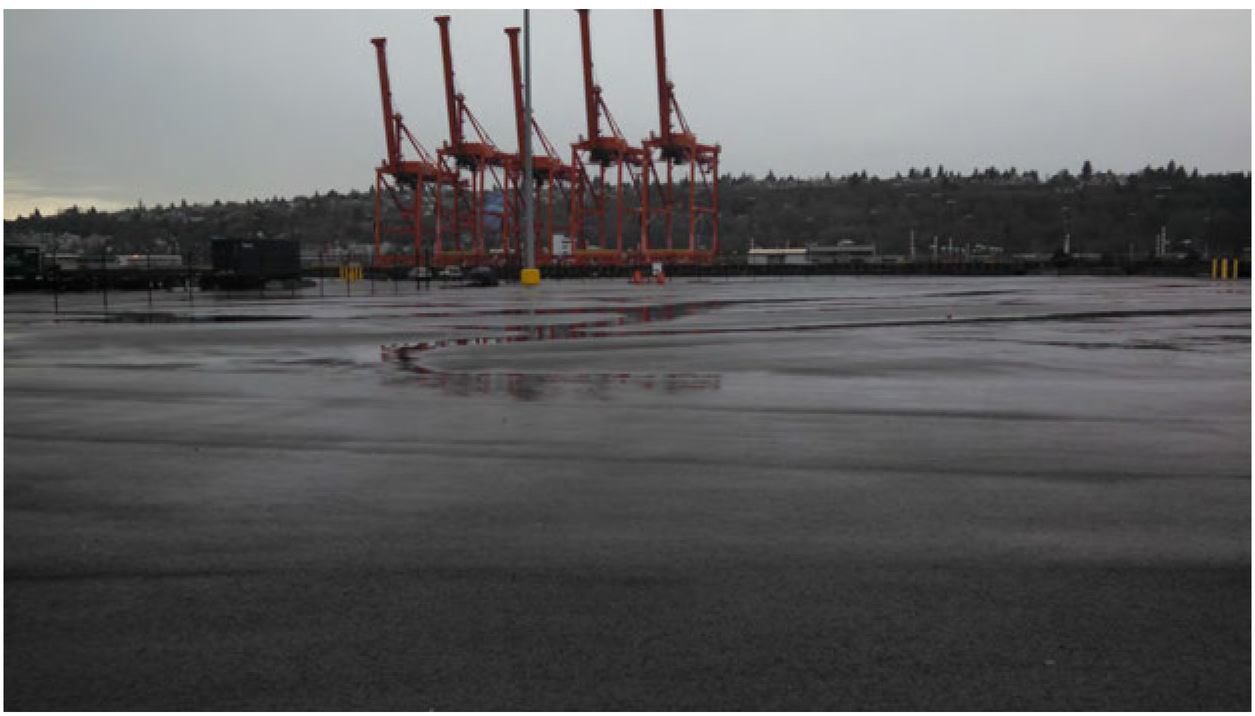

Photo 11. Vigor Shipyard south of ARCO

Photo 12. Crack repairs

Photo 13. Small cap on north end of OU3 (vegetation present)

Soil and Groundwater OU1 (Todd Uplands)

Photo 14. Extraction well FW-19

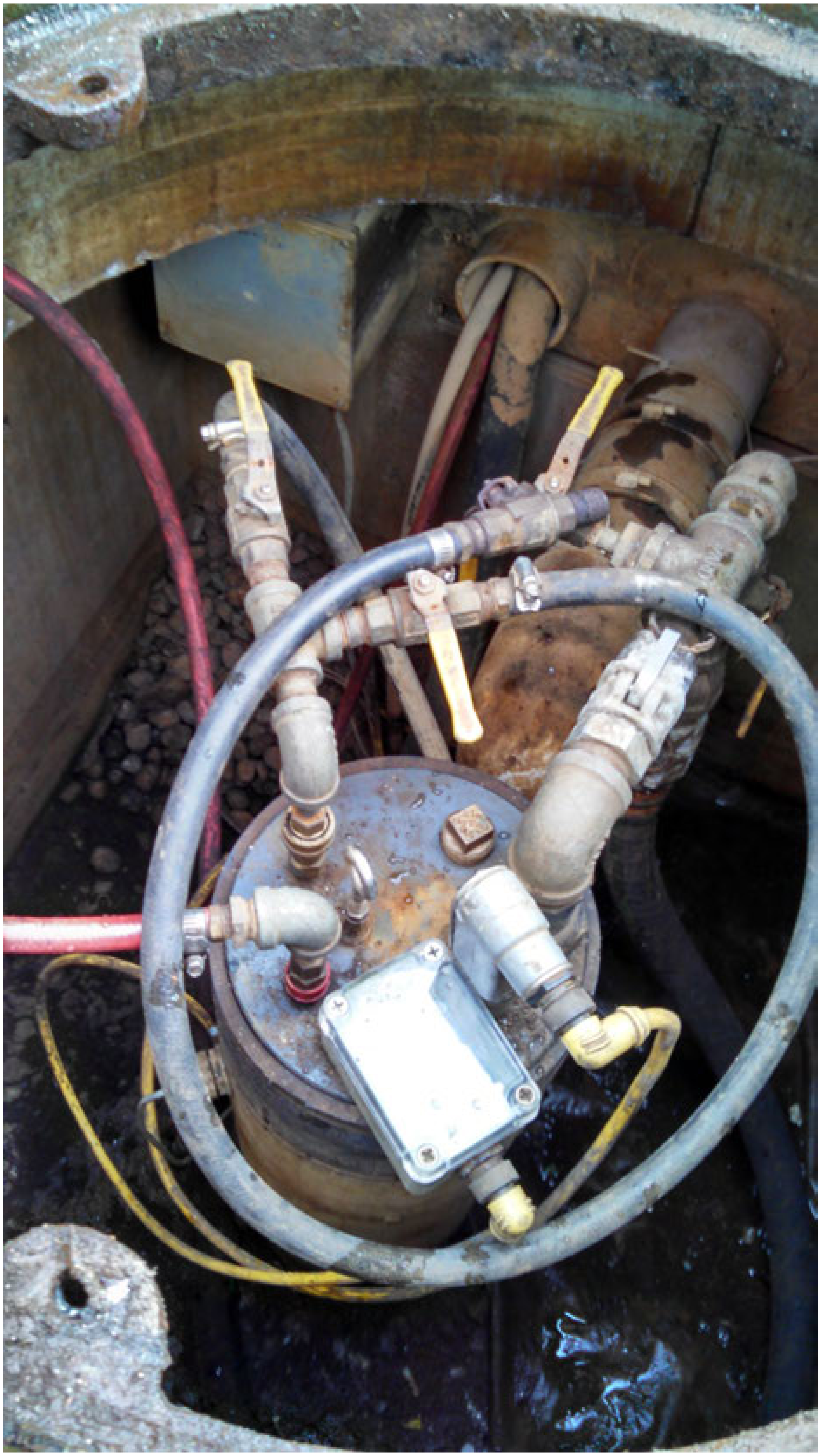

Photo 15. Extraction well FW-18

Photo 16. West LNAPL Shed controls

Photo 17. West LNAPL Shed carbon vessels

Photo 18. West LNAPL Shed LNAPL tank and catalytic oxidizer

Photo 19. East LNAPL Shed (inactive)


Photo 20. East LNAPL Shed (inactive)

Photo 21. Cap on Todd Uplands

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Harbor Island Superfund Site, OU1 and OU3	**Date of inspection:** 04 February 2015
Location: Seattle, WA	**EPA ID:** WAD980722839
Agency, office, or company leading the five-year review: EPA	**Weather/temperature** Overcast, windy, cool, occasional light rain

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other: *e.g. Groundwater monitoring*
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

The pump and treat system is related to LNAPL extraction on the Todd Uplands; Asphalt soil caps are present across much of OU1 and OU3

Attachments: ☒ Inspection-team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ______________________ ______________________ ______________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______________
   Problems, suggestions; ☐ Report attached ____

2. **O&M staff** ______________________ ______________________ ______________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______________
   Problems, suggestions; ☐ Report attached ____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____

4. **Other interviews** (optional) ☐ Report attached.

Interviews were not performed during the site visit. Rather, interviews were performed via e-mail afterwards. Appendix E documents the interviews.

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

1. **O&M Documents**

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

Remarks O&M Manuals are available electronically. Maintenance is logged, and is summarized in periodic reports.

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☐ Up to date ☐ N/A
☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A
Remarks

No.	Item	Readily available	Up to date	N/A
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	☐ N/A
	Remarks: Training records are not kept on site, but rather are kept by the particular contractors responsible for maintenance.			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☐ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☐ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits______________________	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	☐ N/A
	Remarks			
8.	**Leachate Extraction Records**	☒ Readily available	☒ Up to date	☐ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☐ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☐ N/A
	Remarks			
10.	**Daily Access/Security Logs**	☒ Readily available	☒ Up to date	☐ N/A
	Remarks: Access to OU1 is managed by security guards; there are sign in sheets, or other identification is necessary to access the site.			

IV. O&M COSTS

1. **O&M Organization**

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

2. **O&M Cost Records**

☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place

Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From (Date)	To (Date)	Total cost	
			☐ Breakdown attached
			☐ Breakdown attached
			☐ Breakdown attached
			☐ Breakdown attached
			☐ Breakdown attached

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

Describe costs and reasons:

O&M cost records were not provided or estimated during the site visit. Unanticipated or unusually high O&M costs were not discussed. The interview records in Appendix E provide estimates for annual O&M costs for most OUs and briefly discuss unanticipated or unusually high O&M costs.

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

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks Fencing is in good condition.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks Signs and other security measures, like security guards at gates, are in good condition or performing their function adequately.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented	☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced	☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ________

Frequency ________

Responsible party/agency ________

Contact ________ ________ ________ ________

Name Title Date Phone no.

Reporting is up-to-date	☐ Yes ☐ No ☒ N/A
Reports are verified by the lead agency	☐ Yes ☐ No ☒ N/A
Specific requirements in deed or decision documents have been met	☐ Yes ☐ No ☐ N/A
Violations have been reported	☐ Yes ☒ No ☐ N/A

Other problems or suggestions: ☐ Report attached

ICs have not been implemented as required in decision documents in several capped areas in OU 1 and OU3

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

Remarks ICs are adequate in areas where they have been implemented. Many capped areas do not yet have ICs in place.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks

2. **Land use changes on site** ☒ N/A

Remarks

3. **Land use changes off site** ☒ N/A

Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks Roads to the site and on-site remain adequate.

B. Other Site Conditions

Remarks

Cracking was apparent in several places of the S&G OU1 asphalt cap. The cap is monitored annually. When cracks become too large or material comes loose, the cracks are repaired.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. 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

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

B. Benches ☐ N/A ■ Applicable

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay
Remarks

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks

C. Letdown Channels ■ Applicable ☐ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent______________ Depth____________
Remarks

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type_______________ Areal extent_____________
Remarks

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent______________ Depth____________
Remarks

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks
D. Cover Penetrations	☐ Applicable ☐ N/A
1.	**Gas Vents** ☐ N/A ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration Remarks
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks
3.	**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
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐N/A Remarks

E. Gas Collection and Treatment	☐ Applicable	☐ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks		
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks		
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks		
F. Cover Drainage Layer	☐ Applicable	☐ N/A	
1.	**Outlet Pipes Inspected** Remarks	☐ Functioning	☐ N/A
2.	**Outlet Rock Inspected** Remarks	☐ Functioning	☐ N/A
G. Detention/Sedimentation Ponds	☐ Applicable	☐ N/A	
1.	**Siltation** ☐ N/A ☐ Siltation not evident Areal extent_______________ Depth_____________ Remarks		
2.	**Erosion** Areal extent_______________ Depth_____________ ☐ Erosion not evident Remarks		
3.	**Outlet Works** ☐ Functioning ☐ N/A Remarks		
4.	**Dam** ☐ Functioning ☐ N/A Remarks		

H. Retaining Walls ☐ Applicable ☐ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement_____________ Vertical displacement_______________
Rotational displacement_____________
Remarks

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks

I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A

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

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent_______________ Depth_____________
Remarks

4. **Discharge Structure** ☐ Functioning ☐ N/A
Remarks

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent_______________ Depth_____________
Remarks

2. **Performance Monitoring** Type of monitoring___________________________
☐ Performance not monitored ☐ Evidence of breaching
Frequency________________________________ Head differential___________________________
Remarks

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☒ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks LNAPL extraction pumps and wellhead plumbing at the West LNAPL Shed on Todd Uplands (OU1) are in good condition and operating properly.

2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition ☐ Needs Maintenance Remarks
3.	**Spare Parts and Equipment** ☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks
B. Surface Water Collection Structures, Pumps, and Pipelines	☐ Applicable ☒ N/A
1.	**Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks
C. Treatment System	☐ Applicable ☐ N/A
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☒ Oil/water separation ☐ Bioremediation ☐ Air stripping ☒ Carbon adsorbers ☐ Filters__________ ☐ Additive (*e.g.*, chelation agent, flocculent)__________ ☐ Others Thermal Oxidizer ☒ Good condition ☐ Needs Maintenance ☒ Sampling ports properly marked and functional ☒ Sampling/maintenance log displayed and up to date ☒ Equipment properly identified ☐ Quantity of groundwater treated annually__________ ☐ Quantity of surface water treated annually__________ Remarks The only treatment system observed was the west LNAPL shed on the Todd Uplands (OU1).
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks In good condition.

3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance Remarks
4.	**Discharge Structure and Appurtenances** ☐ N/A ☒ Good condition ☐ Needs Maintenance Remarks
5.	**Treatment Building(s)** ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair ☒ Chemicals and equipment properly stored Remarks
6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks Some wells had a bolt or two missing, but the wells were still secured.
D. Monitoring Data	
1.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
2.	Monitoring data suggests: ☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks
X. OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. 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.).

The remedies at OU1 and OU3 are effective, but are not functioning as designed. There is no evidence that contaminants are discharging to nearby waterways, and the soil caps provide more than adequate protection against exposure to contaminated soil. However, institutional controls in the form of restrictive covenants are not in place at all of the capped properties.

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.

O&M has generally been adequate to maintain the integrity of the asphalt caps at OU1 and OU3. However, cap inspection and monitoring reports from some of the properties in OU1 are not consistently submitted as required.

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.

There were no early indicators of potential remedy problems at OU1 or OU3.

D. Opportunities for Optimization

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

The groundwater monitoring programs for OU1 and OU3 should be reviewed for optimization opportunities. For example, the monitoring frequency or the analyte list could be reduced.

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Appendix F: Photographs from TANK FARMS Site Inspection Visit

BP West Coast Products Terminal, former ARCO Harbor Island Terminal Site
Appendix F. Photo Log

Photo 1. BP Terminal Harbor Island illustrating one petroleum fuels loading rack looking northwest.

Photo 2. BP Terminal seawall parallel to loading rack on right, green boom to capture any sheen or floating product on West Waterway is a safety measure. Foreground is piping for on-loading and off-loading petroleum from barges or ships at West Waterway. Left is barge and ship dock with Elliott Bay is in background.

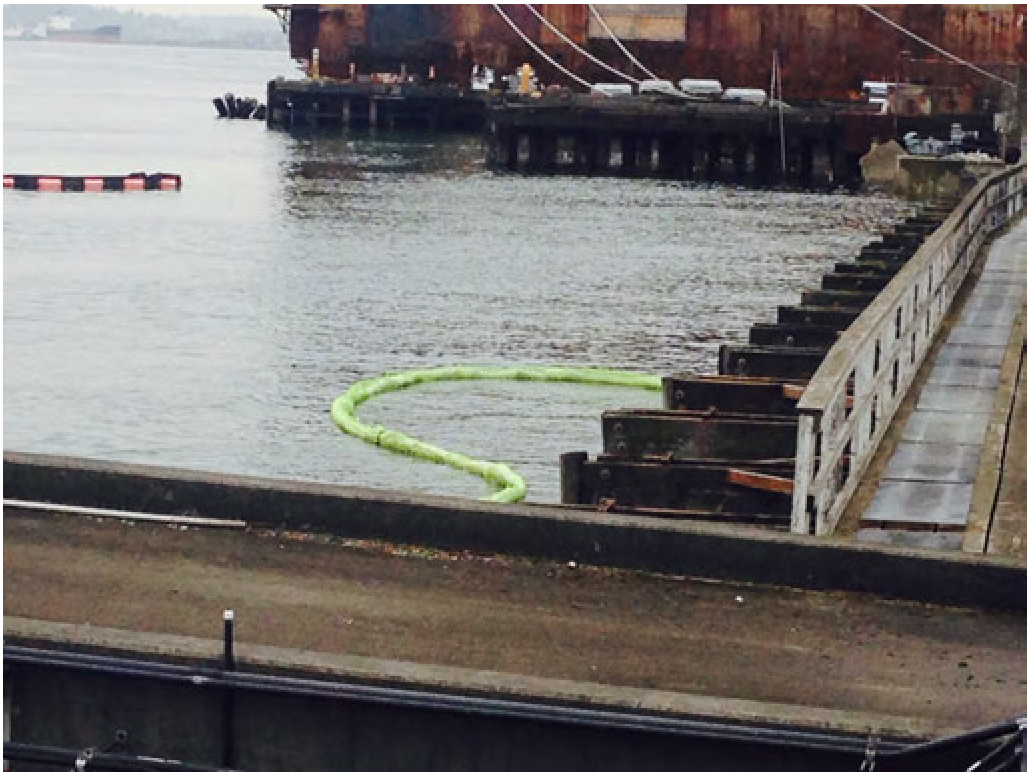

Photo 3. BP Terminal seawall and green boom to capture any sheen or floating product on West Waterway as a safety measure, and photo looking NNW at West Waterway and Elliott Bay in the background.

Photo 4. BP Terminal continuation of photo 2 showing on-loading and off-loading petroleum fuels piping and dock at West Waterway looking westward in distance is the north edge of West Seattle.

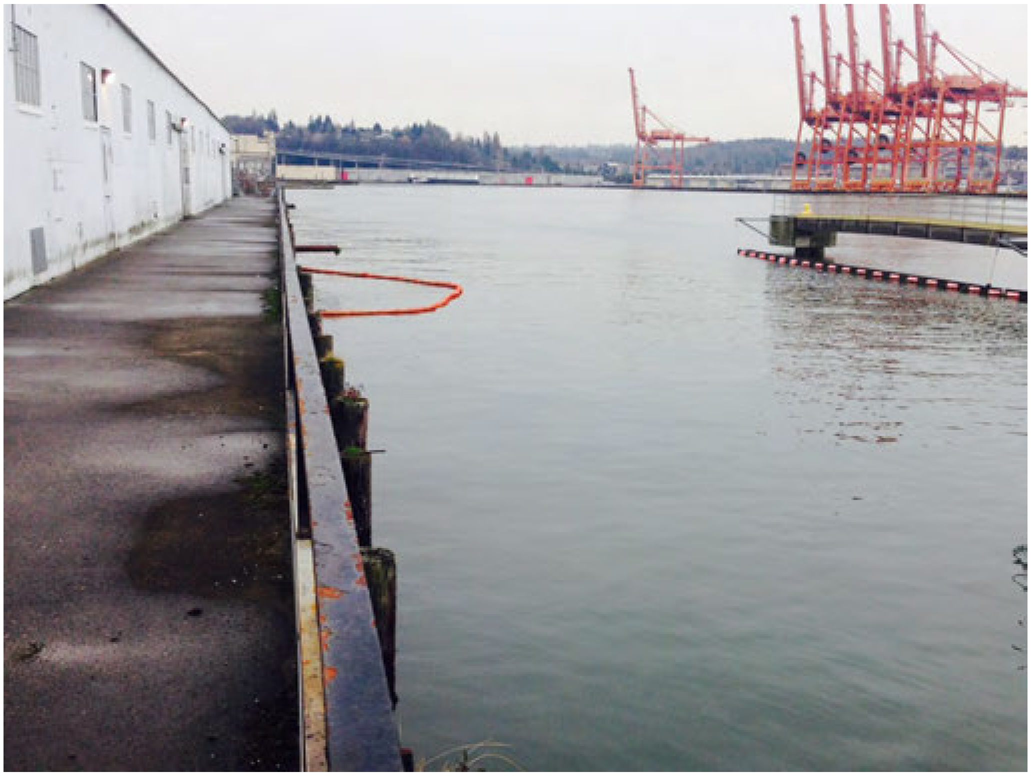

Photo 5. BP Terminal looking south along the seawall and West Waterway with orange boom to capture any sheen or floating product on waterway as a safety measure. Along this walkway are near shore compliance monitoring wells to evaluate current conditions and protect waterway. Well heads not easily visible.

Photo 6. BP Terminal showing Compliance Monitoring Well AMW-01 to the left and behind the yellow bollard. Additionally, Recovery Well RW-10 is located directly behind AMW-01. Recovery Well RW-10 is an active pumping well utilized as part of the Groundwater/LNAPL Recovery System. Well heads are flush mounted to ground surface.

Photo7. BP Terminal Soil Vapor Extraction Remediation System equipment is shown with pumping station, vapor removal and stripping system and six individual well piping with control valves. This system is removing petroleum vapors from soil and groundwater for subsurface cleanup action.

Photo 8. BP Terminal detail for the Soil Vapor Extraction Remediation System showing 11 individual well control valves and piping. Blue airlines to right were installed as a contingency in case additional remedial technologies, such as air sparging, would be needed to meet site cleanup objectives. This system is removing petroleum vapors from soil and groundwater for subsurface cleanup action.

Photo 9. BP Terminal Plant 1 at south wall looking east where above ground storage tank (AST) No. 8 with monitoring well GM-16S is located in distance at the southeast corner of Plant 1.

Photo 10. BP Terminal outside south wall for Plant 1 where new materials for new seawall are temporarily stored and waiting permit approval to replace West Waterway seawall and AST No. 9 and 13 in background.

Kinder Morgan Liquids Terminals LLC, former GATX Terminals Harbor Island Site
Appendix C. Photo Log on November 19, 2014

Photo 1. KMLT illustrating a petroleum fuels loading rack.

Photo 2. Above ground petroleum Storage Tanks (ASTs) showing site conditions and maintenance.

Photo 3. KMLT Above ground petroleum Storage Tank No. 33 at B Yard with containment wall and piping on left with two Arcadis consultants conducting the site inspection.

Photo 4. KMLT Above ground petroleum Storage Tank No 35 at E Yard with supply piping and valves.

Photo 5. Overhead supply piping between KMLT yards showing impermeable (paved) and permeable (gravel) surfaces and current site conditions.

Photo 6. KMLT Above ground petroleum Storage Tank and supply piping with containment wall to right.

Shell Oil Harbor Island Terminal, former Equilon Enterprises LLC Harbor Island Terminal Site
Appendix C. Photo Log on November 4, 2014

Photo 1. Shell Oil Products Harbor Island Terminal Site showing location of SH-04 Area.

Photo 2. Shell Harbor Island Terminal Shoreline Manifold Area looking northeast across Elliott Bay to City of Seattle in background.

Photo 3. Shell Shoreline Manifold Area looking northwest to Port of Seattle.

Photo 4.

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Appendix G: Copy of Public Notice

EPA to Review Cleanups at Harbor Island Superfund Site

United States Environmental Protection Agency

The U.S. Environmental Protection Agency is beginning the fourth five-year review of the environmental cleanups at the Harbor Island Superfund Site. Harbor Island is a 420-acre man-made island and industrial area located in the Duwamish River delta adjacent to Elliott Bay in Seattle. Cleanups completed on Harbor Island were focused on the spread of lead, other metals, petroleum and industrial contaminants throughout the island and adjacent waters. The result is a complex cleanup site which includes several distinct project areas and objectives.

The areas being reviewed, including contact information, are:

- **East Waterway, Lockheed Uplands, Soils and Groundwater -**
  Ravi Sanga at: sanga.ravi@epa.gov or: 1-800-424-4372 ext. 4092**;**
- **Lockheed Shipyard Sediments and Todd Shipyard Sediments -**
  Lynda Priddy at: priddy.lynda@epa.gov or 1-800-424-4372 ext. 1987;
- **West Waterway -**
  Karen Keeley at: keeley.karen@epa.gov or: 1-800-424-4372 ext. 2141;
- **Tank Farms (Petroleum), Washington Department of Ecology (Lead) –** Maura O'Brien at: Maura.Obrien@ecy.wa.gov or: (425) 649-7249.

EPA reviews Harbor Island every five years to make sure the cleanup continues to be protective of people and the environment. After the review, EPA will prepare a report for each of the project areas to explain the results, which will be completed by September 2015.

As someone familiar with the site you may know things that can help our review team determine whether the different areas are still safe. If you have information you would like us to consider during our review, please contact the project manager for that particular project area or Julie Congdon, EPA Community Involvement Coordinator, at 800-424-4372 ext. 2752 or congdon.julie@epa.gov no later than December 31, 2014.

For more information or to review site documents visit the web page at:

http://go.usa.gov/5ppP

Documents can also be reviewed at the EPA Superfund Records Center, 1200 Sixth Avenue, Seattle, WA 98101. (*Please call for an appointment, toll-free: 1-800-424-4372 ext. 4494)*

TDD and/or TTY users may call the Federal Relay Service at 1-800-877-8339 and give the operator Ravi Sanga's number 1-800-424-4372 ext. 4092.