Five-Year Review Report

First Five-Year Review Report
Pacific Sound Resources
Superfund Site
Seattle, Washington

EPA Region 10

Prepared by:

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Under Contract To:

Port of Seattle

September 28, 2004

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EPA Region 10

Approved by:

Daniel D. Opalski, Director
Office of Environmental Cleanup Office
US EPA Region 10

9/30/04
Date

September 28, 2004

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List of Acronyms

ACL	Alternate Concentration Limit
AOC	Administrative Order on Consent
bgs	below ground surface
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Constituents of Concern
DNAPL	dense nonaqueous phase liquid
EPA	United States Environmental Protection Agency
I&M	Inspection and Maintenance
LNAPL	light nonaqueous phase liquid
MLLW	Mean Lower Low Water
MSU	Marine Sediment Unit
MTCA	Model Toxics Control Act
NAPL	nonaqueous phase liquid
NCP	National Contingency Plan
NPL	National Priorities List
PAH	polynuclear aromatic hydrocarbon
PCP	pentachlorophenol
POC	point of compliance
POS	Port of Seattle
PPA	Perspective Purchaser Agreement
PSR	Puget Sound Refinery
RAO	Remedial Action Objective
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SAOC	Supplemental Administrative Order on Consent
SAP	Sampling and Analysis Plan
SEPA	State Environmental Policy Act
µg/L	micrograms per liter

Five-Year Review Summary Form

Site Name *(from WasteLAN)*: Pacific Sound Resources (PSR) Superfund Site

EPA ID *(from WasteLAN)*: 10L

Region: 10	State: WA	City/County: Seattle, King

NPL Status: Final Deleted

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

Multiple OUs?* Yes No | Construction Completion Date:

Has the site been put into reuse? Yes No

Lead Agency: EPA State Tribe Other Federal Agency: ____________________________

Author Name: Sally Thomas / Katie Hendrickson

Author Title: Project Manager / Engineer Author Affiliation: EPA / RETEC

Review Period: ** to

Date(s) of site inspection: 02/05/2004 (most recent I&M inspection)

Type of review:

Post-SARA Pre-SARA NPL-Removal Only

Non-NPL Remedial Action Site NPL State/Tribe-lead

Regional Discretion

Review Number: 1 (first) 2 (second) 3 (third) Other (specify):

Triggering Action:

Actual RA Onsite Construction at OU # ______ Actual RA Start at OU# ______

Construction Completion Previous Five-Year Review Report

Other (specify): Signature of ROD

Triggering action date *(from WasteLAN)*: 09/30/1999

Due Date *(five years after triggering action date)*: 09/30/2004

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

Five-Year Review Summary Form (cont'd.)

Issues:

Summarize issues (see Chapter 3).

1. Groundwater concentrations were detected above the ACLs
2. The ACLs were not appropriately calculated.
3. DNAPL has accumulated in a monitoring well.
4. Lack of complete institutional controls.

Recommendations and Follow-Up Actions:

Summarize recommendations and follow-up actions (see Chapter 3).

1. Continue monitoring quarterly to collect sufficient data to complete seasonality trend analysis.
2. EPA will determine next steps.
3. Try and collect representative groundwater sample from this well. Determine next steps based on the results (e.g. install replacement well)
4. Record land and groundwater use restrictions against the deed and ensure restrictive covenants are in place.

Protectiveness Statement(s):

Include individual operable unit protectiveness statements. For sites that have reached construction completion and have more than one OU, include an additional and comprehensive protectiveness statement covering all of the remedies at the site (see Chapter 4).

The remedy for the Upland Groundwater Unit is protective of human health and the environment. Confirmational sampling will continue and institutional controls will be put in place within the next year to assure protectiveness in the future.
The remedy for the MSU is expected to be protective of human health and the environment on completion.

Other Comments:

Make any other comments here.

1 Introduction

The Pacific Sound Resources (PSR) Superfund Site is a former wood treating facility in Seattle, Washington. The PSR Site is divided into two operable units: the Upland Groundwater Unit and the Marine Sediment Unit (MSU). The Record of Decision (ROD) for the PSR site was signed on September 30, 1999. The ROD adopted previous early actions conducted at the site as the final remedial actions for the Upland Groundwater Unit. In accordance with CERCLA and the National Contingency Plan (NCP), a five-year review of the remedial actions is now required. Remedial work on the Marine Sediment Unit is ongoing and will be completed in 2005. This five-year review focuses on the Upland Groundwater Unit.

The purpose of a five-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in the Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and recommendations to address them.

The Agency is preparing this five-year review pursuant to CERCLA 121 and the NCP. CERCLA 121 states that:

> *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 than each five years after initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

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

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

The United States Environmental Protection Agency (EPA) Region 10 with the assistance of The RETEC Group (RETEC) has conducted a five-year review of the Upland Groundwater Unit remedial action implemented at the PSR site in Seattle, Washington. This review covers the time period from September 1999 to September 2004. RETEC conducted the document review, data analysis and technical assessment of the remedy. Upland Groundwater Unit site work over the five year period has been completed by contractors of the Port of Seattle, largely RETEC and Onsite Enterprises, Inc. This report documents the review.

This is the first five-year review for the Upland Groundwater Unit at the PSR site. The triggering action for this review is the date of ROD signature. The review is being conducted since hazardous contaminants are on site and unlimited use and unrestricted exposure are not allowed.

1.1 Settlement Structure

The Wyckoff/PSR principals settled their liability with the United States of America in a 1994 Consent Decree (CD) in which they gave all ownership shares of PSR (i.e., all of PSR's assets) to the CD-created PSR Environmental Trust. Upon entry of the CD, the Trust sold the portion of the site owned by PSR to the Port of Seattle (POS), along with a PPA from EPA, for a commitment from the POS to perform $9 million plus of in-kind environmental work, plus an additional contribution of reimbursable in-kind work directed towards completion of the Upland Groundwater Operable Unit work. The POS implemented this work pursuant to a 1994 AOC with EPA. This work cost approximately $20 million. The Trust reimbursed the POS for its work beyond the $9 million purchase price obligation for the PSR property in accordance with the PPA and AOC. The POS, with The Retec Group, Inc. as its contractor, is continuing to perform reimbursable work at the site pursuant to a supplemental AOC and the PPA.

1.2 Upland Groundwater Unit Early Actions

As indicated above, the PSR site is divided into an Upland Groundwater Unit and a Marine Sediment Unit. The ROD addresses both units; however, this five-year review is for the Upland Groundwater Unit only. Early cleanup actions were completed to address threats posed by contaminated soil and groundwater and shallow NAPL in the Upland Groundwater Unit. Included in these actions were the installation of a subsurface containment wall and LNAPL collection trench along the northern site perimeter and the placement of a low-permeability surface cap over the Upland Groundwater Unit. The subsurface slurry wall was designed to minimize flow of contaminated groundwater and LNAPL to Elliott Bay and reduce tidal influence on contaminant movement below ground surface. The purpose of the cap was to isolate contaminated soil and reduce groundwater recharge (and associated contaminant mobilization). Early actions were completed concurrently with the early stages of the RI/FS process.

PSR groundwater met cleanup requirements under the NCP and threshold requirements for cleanup actions under MTCA without implementation of additional engineered remedial measures. What was selected as an early action was the final action.

1.3 Upland Groundwater Unit Additional ROD-Required Actions

An Inspection and Maintenance (I&M) program was developed to ensure the long-term structural integrity of the cap installed over the Upland Groundwater Unit. The program consists of scheduled visual cap inspections and specific repair and maintenance protocols.

Institutional controls are the use of legal or administrative systems to reduce the potential for human exposure to contaminated soil and groundwater in the Upland Unit. The current and projected future land use of the Upland Groundwater Unit is primarily industrial (i.e., use as a paved intermodal rail yard) and the groundwater beneath the PSR site will not be used as a potable water supply. The institutional controls necessary to ensure the continued protection provided by the early actions are actions that will assure the current land use is maintained and the aquifer remains unused.

Monitoring is intended to confirm the long-term effectiveness of the early actions. Monitoring of the Upland Groundwater Unit consists of two components. The first component is the monitoring of groundwater quality to ensure compliance levels continue to be met (i.e., concentrations of contaminants of concern do not exceed cleanup levels at the mudline). Because the direct measurement of water quality at the mudline is impracticable, monitoring wells located in the shoreline area are utilized to evaluate compliance. These wells allow for monitoring of groundwater quality at two depths outside the containment wall and along the shoreline.

The second component is designed to monitor DNAPL attenuation. This monitoring is required to confirm the conclusion in the RI that the volume of mobile, free-phase DNAPL beneath the site is very limited, and to provide a warning in the case of an unexpected change in conditions. This component consists of gauging DNAPL thickness in wells and removing DNAPL from wells.

1.4 Marine Sediment Unit Remedial Actions

The remedial action is ongoing in the MSU and will be completed in February 2005. The selected remedial actions for the MSU included:

- Capping 58 acres of contaminated sediments to isolate and stabilize contaminated marine sediments (this is approximately 55,000 cubic yards of clean material)
- Dredging 10,000 cubic yards of contaminated sediment to allow for continued barge and tug access
- Removing unused pilings (approximately 800)
- Implementing institutional controls to prohibit large anchor use in the cap area

2 Site Chronology

The PSR Superfund site is a former wood treating facility located adjacent to Elliott Bay, on Terminal 5 in the Port of Seattle, Washington. Wood was treated at the site from 1909 to 1994 using various treating solutions (creosote, pentachlorophenol, and metals). Soil and groundwater were impacted by these historic operations and nonaqueous phase liquids (NAPL) are present in the subsurface. The site was placed on the National Priorities List (NPL) and investigatory and remedial activities have been conducted under CERCLA. The site chronology is as follows:

Event	Year(s)
Site Developed by J.M. Coleman Company	1909
Wood treating operations on site	1909 – 1994
Site ownership transferred to West Coast Wood Preserving Company (jointly owned by J. M. Coleman Co. and Pacific Creosoting)	1930
Site ownership transferred to Baxter-Wyckoff Company (jointly owned by J. H. Baxter Co. and Mr. Walter Wyckoff)	1959
Site ownership transferred to Wyckoff Company	1964
Site ownership transferred to Pacific Sound Resources	1991
Site ownership transferred to Port of Seattle	1994
NPL Listing	1994
A Consent Decree was entered into between the US Government and the Pacific Sound Resources Company; the decree created an environmental trust for funding the cleanup actions	August 1994
Administrative Order on Consent (AOC) between the Port of Seattle and the Environmental Protection Agency (EPA) signed	September 29, 1994
Initiation of Upland Groundwater Unit RI/FS	1994
Time Critical Early Actions: Demolition of entire wood treating facility and removal of 4,000 cubic yards of contaminated soil and process sludge and initial redevelopment of the site as an intermodal railyard and container terminal	1995
Non – Time Critical Early Actions: Installation of slurry wall and LNAPL recovery trench and completion of asphalt cap over layer of clean fill placed	1996 - 1998
Initiation of Marine Sediment Unit RI/FS	1996
RI/FS for Upland Groundwater Unit completed	November 13, 1998
Inspection and maintenance of surface cap begins	1998
Public comment period for RI/FS reports and Proposed Plan for the PSR site	April 15 – May 15, 1999

ROD was issued stating that the early remedial actions for the Upland Groundwater Unit were the final action and included additional requirements to ensure the actions remain protective. They include 1) inspection and maintenance of the surface cap, 2) confirmational monitoring including groundwater sampling and DNAPL recovery, and 3) placement of institutional controls to prohibit groundwater use and restrict land use	September 30, 1999
Assessment of potential damage to slurry wall as result of 2001 Nisqually earthquake; Wall determined to be functioning effectively	2001 - 2002
Assessment and repair of damage to monitoring wells as result of 2001 Nisqually earthquake	2001 - 2003
Supplemental AOC signed between the Port of Seattle and the EPA	December 2, 2002
Additional monitoring wells installed to complete the confirmational monitoring network	May 2003
Confirmational monitoring begins	May 2003
First Annual Report of Confirmational Monitoring	June 7, 2004

3 Background

The former PSR wood treating facility is located on the south shore of Elliot Bay in Puget Sound at 2801 S.W. Florida Street, Seattle, Washington. The Upland Groundwater unit occupies approximately 25 acres. The specific source locations within the Upland Groundwater Unit are discussed in further detail below.

3.1 PSR Site Ownership and Use

The Upland Groundwater Unit of the PSR Site is located in an industrial portion of West Seattle, which is a fairly densely populated residential area (Figure 3-1). The nearest residence is over one-quarter of a mile from the site. The Upland Groundwater Unit and the surrounding areas to the east and the south are currently part of the Port of Seattle Terminal 5 intermodal yard. The property to the west is used as a barge transport facility for bulk material. To the north, the Upland Groundwater Unit is bordered by Elliot Bay.

As detailed in Section 2.0, wood treating operations were conducted at the site by various companies from 1909 to 1994. These various companies owned and had operations on the PSR site. The State of Washington Department of Natural Resources owns the filled tideland seaward of the inner harbor line. This portion of the site was utilized under lease agreements with the wood treating companies.

Wood treating operations changed through time at the PSR Site. The plant evolved over time from a small pile-supported facility constructed in a subtidal zone over water to a relatively large treating facility constructed on fill. The original wood-treating facility consisted of one shed (eventually known as the "main shed"). Initially, one retort was in operation. Additional retorts were installed in 1912 (four), 1927 (two retorts), 1961 (one retort) and 1967 (one retort). The main dock on the northern terminus of the PSR site was constructed before 1917. There are no recorded dates for the construction of other former PSR site structures. The site layout prior to early actions is shown on Figure 3-2 and a photograph of the site during operation is shown on Figure 3-3.

The PSR Site is currently owned by the Port of Seattle (south of the inner harbor line). During the early remedial actions, a public access area including an observation tower and walkway was constructed in a portion of the Upland Groundwater Unit. The public access area lies on property owned by both the Port of Seattle and DNR. The remaining portion of the Upland Groundwater Unit was completed as part of a larger intermodal terminal and is currently being leased by APL. The renewable lease expires in 2029. The PSR Site use is anticipated to remain industrial in the foreseeable future.

3.2 PSR Site Setting

The Upland Groundwater Unit of the PSR Site has been used for industrial purposes since its filling. The Upland Groundwater Unit is mainly covered with asphalt limiting the habitat for most terrestrial plants and animals found in the Duwamish River/Elliot Bay region. The Upland Groundwater Unit lies adjacent to the southwest portion of Elliot Bay and the West Duwamish Waterway. These water bodies are a portion of the adjudicated usual and accustomed fishing area of the Muckleshoot and Suquamish Indian tribes.

3.3 PSR Site Impacts

Contamination of the site is associated with the former wood-treating processes and facilities. Investigations indicated the releases of wood treating material occurred throughout the lifetime of the facility. The primary wood preservatives in use at the time of plant closure were creosote, PCP, and chemonite (an inorganic solution of copper, arsenic, and zinc salts). Other preservatives used during historic plant operations included phenol, chromium, boric acid, and fluoride (Science Applications International Corporation, 1990). During the investigation phase, concentrations of these constituents were evaluated. Based on this evaluation, the primary constituents of concern for the site were determined to be polynuclear aromatic hydrocarbons (PAH), pentachlorophenol, dibenzofuran, and zinc.

Specific sources within the former process area include:

1) The former treating area
2) Treated-wood transfer and storage areas
3) Retort and transfer table discharge pits
4) Loading areas
5) Stormwater discharge areas.

The primary sources of contamination to the Upland Groundwater Unit are associated with the treating areas, discharge pits, and loading areas. The site conceptual model is shown on Figure 3-4. These primary sources were removed during early remedial actions (demolition and materials removal) under CERCLA authority. The remaining sources at the PSR site are the secondary sources (contaminated media). The primary secondary source for the Upland Groundwater Unit is DNAPL which is located in soil both above and below the water table. The volume of LNAPL at the site is limited. The DNAPL is a secondary source to groundwater, and the impacted groundwater could potentially affect sediment and surface water.

The Marine Sediment Unit was contaminated primarily through direct disposal of contaminated materials to Elliot Bay (Weston, 1998).

4 Remedial Actions

Cleanup actions for the Upland Groundwater Unit of the PSR Site were completed as early action removals. No additional engineered remedial measures were required by the ROD; however the ROD discusses requirements to ensure the actions remain protective.

The Remedial Investigation and Feasibility Study (RI/FS) report for the Upland Groundwater Unit is dated November 13, 1998. The RI/FS report for the Marine Sediment Unit is dated November 1998. The ROD was issued on September 30, 1999.

4.1 Remedial Action Objectives

The early actions eliminated the risk associated with the contaminated soil; therefore only remedial action objectives (RAOs) for groundwater and sediment are stated in the ROD. The RAOs for the groundwater pathway are:

- Protection of aquatic life in surface water and sediments from exposure to constituents of concern (COC) above protective levels

- Protection of humans from exposure to groundwater containing COC above protective levels.

4.2 Early Actions

Early actions were completed at PSR to stabilize site conditions, remove sources, address the principal threats posed by contaminated soil and groundwater, and allow for redevelopment of the site. These early actions were adopted as the final engineered remedial actions for the site. Time-critical and non-time-critical early actions included:

- Site stabilization and demolition
- Removal of source material
- Installation of a slurry wall and LNAPL recovery trench
- Installation of a cap and utility corridors.

Site stabilization and source removal actions were designed to eliminate accessible volumes of wood-treating chemicals and process residuals. All above-ground structures were demolished and wood-treating chemicals contained in these structures were disposed. A potential source of groundwater contamination was eliminated through excavation and disposal of approximately 3,840 tons of process residual materials present in the soil.

The subsurface containment wall has a number of significant impacts on groundwater movement and quality. First, the wall prevents migration of any remaining LNAPL to Elliott Bay. LNAPL has not migrated into the LNAPL recovery trench and the remaining volume of LNAPL at the site is very limited. Nevertheless, the LNAPL recovery trench is in place behind the wall to collect and recover any remaining LNAPL that could potentially accumulate upgradient of the wall. Second, lateral migration of DNAPL to Elliott Bay is precluded above the approximate mean base-of-wall elevation of -25 ft MLLW (approximately 45 feet bgs). Third, the wall substantially lowered the flow of contaminated groundwater to Elliott Bay from the shallow upland portion of the site

Placement of a low permeability cap over the site (Figure 4-1) reduced groundwater recharge and eliminated the potential for contaminants to migrate from unsaturated soil to groundwater via stormwater infiltration.

Residual DNAPL is present in the fill under former operational areas and in sand layers in the underlying native deposits. Limited volumes of mobile DNAPL are present. This DNAPL acts as a continuing source of groundwater contamination. However, no additional active remedial measures for the site were required based on a fate and transport analysis completed during the RI/FS that showed the contaminated groundwater meets the selected cleanup levels at the point of compliance (the mudline). As stated in the Record of Decision (ROD) issued by the EPA in 1999,

> *The early actions for soils and groundwater removed most contaminated source material, eliminated direct contact with subsurface soils, eliminated LNAPL discharges to Elliot Bay, minimized discharge of contaminated groundwater and DNAPL to Elliott Bay and significantly reduced the influence of tidal fluctuations at the site. The risk posed by exposure to contaminated soil has been eliminated, and groundwater meets cleanup requirements under NCP and threshold requirements for cleanup action under MTCA without implementation of additional engineered remedial measures.*

4.3 Remedy Description

The early remedial actions were selected as the final actions for the Upland Groundwater Unit (see Section 4.2). In order to ensure the actions remain protective the ROD details three requirements. These requirements include:

- Inspection and maintenance (I&M) of the surface cap
- Confirmational monitoring including groundwater sampling and DNAPL recovery

- Placement of institutional controls to prohibit groundwater use and restrict land use.

This section describes these requirements in further detail. The results and the assessment on whether the requirements have ensured protectiveness are discussed in Section 7.

4.3.1 Inspection and Maintenance

The purpose of the I&M is to ensure future maintenance of the PSR upland cap in a manner that complies with all of the objectives of the cap for the PSR Superfund site which include:

- Preventing direct exposure to contaminants in surficial soils
- Minimizing potential impacts on groundwater related to leaching of contaminants from surficial soils to the groundwater
- Minimizing off-site migration of surficial soils via the surface water runoff to Elliot Bay.

I&M requirements are specified for the asphalt cap inside the intermodal yard and for the public access area. These requirements are detailed in the *Updated Inspection and Maintenance Plan for the Asphalt Cap – PSR Superfund Site* (RETEC, 2004) and the *Inspection and Maintenance Plan for the Public-Access Area at the Pacific Sound Resources Superfund Site* (RETEC, 1998).

I&M requirements for the PSR asphalt cap include:

- Notifications either to or from the facility tenants regarding repairs and/or maintenance efforts that penetrate the cap
- Cap inspections
- Cap maintenance and repairs based upon inspection results.

The asphalt cap inspections consist of two components: an overall inspection of the cap and a focused inspection of various areas of the cap. The purpose of the overall inspection is to examine the cap as a whole to ensure that no obvious damage, settlement, or other problems compromising the integrity of the cap have occurred. The focused inspection more closely examines how various site activities affect the integrity of the cap. This component of the inspection consists of examining predetermined high impact areas of the site.

I&M requirements for the public access area include:

- Inspections by a formal site inspector with a background in construction inspection
- Patrols by the Port of Seattle Police Department.

During formal inspections and patrols of the public access area the physical features of engineering and institutional controls are inspected. These physical features of engineering and institutional controls include informational signs, shoreline fencing and barricades, anti-fishing measures, and site cap and fill.

Results and records of all formal inspections of both the asphalt cap and the public access area are submitted by the Port of Seattle to the EPA. Inspections are currently performed once a year.

There is a separate Operation Maintenance and Monitoring Plan for the Marine Sediment Unit.

4.3.2 Confirmational Sampling

Confirmational sampling consists of:

- Quarterly groundwater sampling
- Quarterly DNAPL monitoring and removal of DNAPL as necessary (removal occurs quarterly and more frequently if the volume of DNAPL removed from a well per event is greater than 2 gallons)
- An evaluation of post-wall groundwater flow.

The requirements and procedures for confirmational sampling are detailed in the *Upland Groundwater Remedy Confirmational Sampling Work Plan* (UGR-CM Plan; RETEC, 2004).

Groundwater sampling is conducted to confirm cleanup standards are being met. The monitoring network for evaluating groundwater quality along the shoreline consists of 12 wells located at two depths outside the containment wall and along the shoreline (Figures 4-2). The well network provides for groundwater quality monitoring at appropriate depths and at a spacing of 100 to 200 feet along the shoreline. The shallow wells are positioned to monitor shallow groundwater discharging through the containment wall into the shallow fill. The intermediate wells are positioned to observe potential impacts from deep groundwater including any flow from under the slurry wall.

Monitoring of DNAPL volumes is conducted to confirm the findings of the RI that the volume of mobile, free-phase DNAPL beneath the site is limited. The DNAPL monitoring confirms that conditions are not changing such that DNAPL is mobilized. DNAPL recovery is intended to deplete remaining source material to the extent possible. The DNAPL monitoring network includes all twelve of the groundwater monitoring wells and six other existing wells that have either historically contained DNAPL or are deep wells (Figure 4-2). All the wells within this network are tested for the presence of DNAPL. Groundwater from wells containing DNAPL is not sampled. Product from wells with measurable amounts of DNAPL is removed and the volume is recorded on a minimum of a quarterly basis. DNAPL measurement and recovery was also conducted prior to initiation of confirmational sampling.

The measurement of the groundwater flow was conducted in 2003/2004 to assess whether the slurry wall was performing as designed. The post-wall groundwater flow was evaluated based on two tidal studies conducted in 2003/2004. The monitoring network for the tidal studies included wells and piezometers within and outside the slurry wall on the PSR Site and adjacent Port of Seattle property (Figure 4-3). Each tidal study was conducted over a five-day period and the best three-day record was used to assess flow. Water levels were measured on an hourly basis to compute tidal efficiency and local gradients. The mean flow was calculated using the method developed by Serfes (Serfes, 1991).

Groundwater monitoring reports are prepared and submitted to EPA on an annual basis.

4.3.3 Institutional Controls

The purpose of institutional controls is to prohibit groundwater use and restrict land use to ensure the early actions remain protective. Notification of these restrictions is required to be recorded against the property deed with restrictive covenants to ensure conforming use by any subsequent purchaser.

4.4 Remedy Implementation

This section discusses the implementation of the selected remedy. Results of the implementation activities are detailed in Section 7.1, which discusses whether the remedy is functioning as intended.

4.4.1 Inspection and Maintenance of Cap

Inspection and maintenance of the surface cap is a requirement of the ROD.

The process for notifications for repairs to the facility was established between the Port of Seattle and the current tenant in the lease agreement. The tenant (currently APL) was also informed of site use requirements such as the restrictions on subsurface activities and loading requirements.

The first formal cap inspection was conducted in 1998. Subsequent inspections have occurred according to the schedule outlined in the I&M Plans and are ongoing. Surface conditions and conditions along structures are the two main components of the cap that are visually inspected. An inspection after a 25-year, 24-hour storm event was conducted after operations began and every three to four years since that time. Storm-related inspections (not necessarily after 25-year, 24-hour storm events) were conducted twice in first year of terminal operations and once per year since that time.

4.4.2 Confirmational Monitoring

Monitoring of the groundwater and DNAPL volume trends is required as stated in the ROD. The annual groundwater flow assessment is specified in the Supplemental Administrative Order on Consent (SAOC, December 2002).

The monitoring program and network was initially outlined in the RI/FS (RETEC, 1998) and finalized in the UGR-CM Plan (RETEC, 2004). As planned, the original monitoring network was modified slightly prior to the first monitoring event. Three new wells were installed in 2003 in lieu of wells containing DNAPL. The three new wells were included in the monitoring network instead of the existing wells since DNAPL in a well may cause measured groundwater concentrations to be overestimated. One of these three new wells accumulated DNAPL during the first year of confirmational sampling and an assessment of whether the well should remain part of the groundwater monitoring network is currently being conducted. Additionally, four replacement wells were installed in 2003 to replace monitoring wells in the groundwater monitoring network that had been damaged by the 2001 Nisqually earthquake or other site activities.

Long term groundwater monitoring was required in the ROD. The SAOC between the Port of Seattle and the EPA, which included implementation of 2 to 3 years of groundwater monitoring, was signed in December 2002. The first groundwater sampling event was conducted in May 2003 and subsequent events occurred on a quarterly basis since that time. To date six sampling events have been completed.

DNAPL measurements and recovery from selected wells has been ongoing since 1996. As shown in the site conceptual model (Figure 3-4), DNAPL exists in thin sand layers. Prior to 1998, six wells were measured and pumped several times a month. DNAPL recovery has decreased with time and after 1998 recovery occurred on a periodic basis ranging from monthly to quarterly from four wells. As discussed above, a monitoring well installed in 2003 as part of the groundwater monitoring network accumulated DNAPL. A pump similar to those used in the other DNAPL containing wells was installed in this well and the DNAPL was recovered. During the first year of confirmational sampling, DNAPL measurement and recovery occurred on at least a quarterly basis from five wells (including the newly installed well which accumulated DNAPL shortly after installation) DNAPL measurements will continue on a quarterly basis and DNAPL recovery will continue as specified in the UGR-CM Plan. DNAPL recovery is consistent with expectations for this site.

The two tidal studies to assess the groundwater flow were conducted in the fall of 2003 and spring of 2004. As the groundwater flow is not expected to change unless there is a material change in the geology, these two tidal studies have shown the pattern of groundwater flow during the wet and dry season and no other tidal studies to assess groundwater flow are anticipated.

4.4.3 Institutional Controls

Land and groundwater use restrictions will be recorded against the deed and restrictive covenants will be put in place by both the Port of Seattle for Port owned property and the State of Washington for State owned property

5 Progress Since the Last Review

As this is the first five-year review, there is no progress from the last review to report.

6 Five-Year Review Process

The five-year review team was lead by Sally Thomas of the EPA Region 10. RETEC under contract to the Port of Seattle authored the five-year review under the supervision of Sally Thomas. The PSR site is relatively low profile. Community involvement included notification in the local newspaper. The advertisement introduced the five-year review, invited suggestions, and solicited information related to the review. No comments or responses were received from the public. The five-year review consisted of a review of relevant documents including decision documents (ROD), remedial action reports, environmental laws and regulations, monitoring reports, and enforcements documents (e.g. supplemental AOC).

Regular site visits occur for monitoring and maintenance purposes. Reports of these visits were reviewed to complete this report.

No interviews were conducted.

7 Technical Assessment

7.1 Is Remedy Functioning As Intended?

The remedy is functioning as intended. As stated previously, the early actions at the site including plant demolition and removal of process residuals, barrier wall installation, and cap construction removed the potential threats to human health and the environment. Ongoing I&M, confirmational monitoring and current land and groundwater use restrictions are in the process of being implemented to ensure that the early actions remain protective. This section discusses the results of I&M and conformational monitoring as well as additional items that support the statement the remedy is functioning as intended.

7.1.1 Inspection and Maintenance

The results of the past inspections have shown that the surface cap is still functioning as originally intended though some maintenance has been required. The surface cap is intended to minimize infiltration of surface water and prevent direct contact with soil.

Based on inspections, cap maintenance is being conducted as needed. Substantial cap maintenance has been necessary on three occasions as follows:

- A minor train derailment occurred at the extreme north end of the track in 2001 destroying the train barricade. The Port of Seattle subsequently installed a new barricade with a concrete foundation and resealed the asphalt at the edges of the concrete pad. The damage was repaired according to specifications.

- The Nisqually earthquake occurred on February 28, 2001 and evidence of earthquake-induced ground motion was noted at the site. Ground cracking and damage to some of the monitoring wells was noted. The locations of cracks in the surface cap as a result of the earthquake were mapped. Cracks were less than ½- inch wide and were repaired in accordance with the inspection and maintenance plans and completed by September 25, 2001.

- A second minor train derailment occurred on a track located on the west side of the property in 2003. Damage from this derailment included a dislodged train barricade. The barricade has been replaced and additional repairs in the immediate vicinity of the barricade are pending. This work is being coordinated with the railroad.

Formal inspections by Onsite Enterprise, Inc. and patrols by the Port of Seattle Police within the public access area have ensured the physical features of engineering and institutional controls are intact. These physical features of engineering and institutional controls include informational signs, shoreline fencing and barricades, and fencing to discourage fishing.

7.1.2 Groundwater Monitoring

Groundwater monitoring is conducted to ensure that transport of COC via groundwater does not adversely affect sediments and surface water. The monitoring is completed in accordance with the UGR-CM Plan (RETEC, 2004). The groundwater quality results are compared to the Alternate Concentration Limits (ACLs) specified in the ROD. The ACLs were computed for each compound using chemical-specific and location-specific factors and therefore, the ACLs for shallow and intermediate wells differ. Table 7-1 lists the ACL for the shallow and intermediate wells. Groundwater quality results are also evaluated for any increasing trends in concentrations.

The concentrations of the COCs have been below the ACLs with a few exceptions. Chemicals detected above the ACLs include benzo(g,h,i)perylene, pentachlorophenol (PCP), naphthalene, dibenzofuran, and indeno(1,2,3-cd)pyrene; however, only benzo(g,h,i)perylene, PCP, and naphthalene have been confirmed at concentrations above the ACL by additional sampling events. Tables 7-2 and 7-3 show the results of all the monitoring events, with concentrations greater than the ROD-specified ACLs highlighted.

Several actions are taken to assess the significance of the concentrations confirmed above the ACL. These actions include:

- Redeveloping the monitoring well
- Reviewing the ACL calculations and the assumptions used.

As discussed below, a review of the ACL calculations showed that the concentrations detected, even though above the ACL, are still protective.

Benzo(g,h,i)perylene has been detected above the ACL in several wells during numerous sampling events. Benzo(g,h,i)perylene is not unusually toxic or mobile as compared to other PAHs, and yet the ACL is lower. As such, the assumptions used in calculating the ACL were reviewed. The review indicated that the organic partition coefficient K_{oc} used in the calculations for benzo(g,h,i)perylene was not the EPA accepted K_{oc} and was two orders of magnitude higher than other generally accepted K_{oc} values. The EPA accepted K_{oc} value is similar in magnitude to other current K_{oc} estimates. Use of these commonly accepted, smaller K_{oc} values results in higher maximum allowable source concentrations in upland wells that are protective of sediments (equivalent to the ACL value). These maximum source concentrations, calculated using EPA published numbers, exceed both the pure solubility (0.26 µg/L) and effective solubility (0.0002 µg/L) for both the shallow and intermediate wells.

Naphthalene was detected slightly above the ACL in one intermediate depth monitoring well, MW-14I, during two sampling events (November 2003 and February 2004). Several PAH concentrations in this well exceed their effective solubilities, which suggest that sediment/solids may have been present in the sample. Therefore, well MW-14I was redeveloped after the February 2004 event. The naphthalene concentration detected during the next event (May 2004) was below the ACL.

The calculation of the ACL for naphthalene was also reviewed. One of the factors used in calculating the ACL was the distance from the well to the point of entry into the surface water. For intermediate wells, the elevation from the midpoint of the screen was used to determine distances to the point of groundwater entry. The shortest distance from any intermediate well in the monitoring network to the POC (200 feet) was used to calculate the ACLs for all the intermediate wells. The distance from the well screen at MW-14I to the POC is 440 feet. Using the same Fate 2 program utilized during the original calculation of the ACLs and changing the distance to the nearest receptor from 200 to 440 feet results in a maximum source concentration of greater than the compound solubility (32,900 µg/L; >S). This analysis indicates that the naphthalene concentrations measured in MW-14I are protective of surface water and sediment. In the most recent sampling event, the naphthalene concentration has decreased to below the ACL.

Pentachlorophenol was detected slightly above the ACL in one shallow monitoring well, MW-14S, during three sampling events (May 2003, November 2003, and February 2004). As a precaution, MW-14S was redeveloped to remove sediment, which could potentially result in anomalous variations in measured groundwater concentration. PCP is not as strongly sorbed to particulates in the well as PAHs and as expected, redevelopment did not reduce the PCP concentrations.

The assumptions used in developing the PCP ACL were reviewed to assess if the PCP concentration may still be protective given the location of MW-14S. The ACLs for all shallow wells were calculated using a uniform distance based on the shortest distance from any shallow well in the monitoring network to the POC. Of the shallow monitoring wells, the closest well to the POC was MW-11S at 55 feet while the other shallow wells are up to 250 feet from the POC. MW-14S is more than 170 feet from the POC. Using a distance of 170 feet with the Fate 2 program the maximum allowable source concentrations is 9,300 µg/L (equivalent of the ACL). This indicates that the PCP concentrations at MW-14S are protective even though they exceed the ACL.

7.1.3 DNAPL Monitoring and Removal

DNAPL volume monitoring continues to indicate that the volume of DNAPL outside the slurry wall is limited. DNAPL was detected in four monitoring wells during the first year of confirmational monitoring (MW-5I, MW-13I, RW-1I, and RW-1D). With the exception of one well, MW-13I, these wells have historically contained DNAPL and been part of an ongoing DNAPL recovery program since 1998. Recovered volumes have diminished over time and the volumes recovered from the wells that have historically contained DNAPL during the first year of confirmational monitoring were less than 1 gallon per quarter from each well.

MW-13I is a new well, installed in May 2003 to augment the confirmational monitoring network. During the second sampling event in September 2003, DNAPL was detected in this well. DNAPL has commonly been encountered in this area before. All three wells that currently produce limited quantities of DNAPL are located within 50 feet of MW-13I (either horizontally or vertically). To date, 19 gallons of DNAPL have been removed from MW-13I. DNAPL has been pumped from MW-13I on a regular basis. The volume of DNAPL recovered from MW-13I diminished after the first two events. A pump was installed and initially 4 gallons were recovered per event. After two months, the volume recovered per event was 2.5 gallons or less.

Table 7.4 shows all the DNAPL recovery events since implementation of the confirmational monitoring.

7.1.4 Tidal Study

The slurry wall was designed to minimize flow of contaminated groundwater and LNAPL to Elliott Bay, and to reduce tidal influence on subsurface contaminant movement. In addition, the wall contains shallow upland DNAPL. The wall design was based on site conditions at that time. Recent assessments of groundwater flow indicate that groundwater gradients are very low and that the flow direction has changed somewhat since design (see Appendix A). Nevertheless, this evaluation indicates that the slurry wall continues to sufficiently contain contaminants and protect Elliott Bay.

Prior to, and during design and installation of the slurry wall, groundwater flowed generally northwestward across the PSR Site (RETEC, 1998). Flow was controlled by the Longfellow Creek drainage on the west side of the site and Elliott Bay to the north. During redevelopment of the area, and after the installation of the wall and completion of the RI/FS, the piping conveying Longfellow Creek to Elliot Bay was tightlined. Subsequent measurements of groundwater flow have indicated that this sealing of the drainage pipe caused the groundwater flow direction to shift. Groundwater studies after the tightlining of the creek have shown flow to the northeast (Aspect, 2000, RETEC, 2004). Based on this approximately 90-degree shift in flow direction, effectiveness of the slurry wall for containing groundwater has been reviewed in more detail.

A groundwater flow assessment in the vicinity of the slurry wall was completed using data collected from the two tidal studies conducted during the first year of confirmational sampling. Mean groundwater elevations were calculated based on these tidal studies (RETEC, 2004). The direction and magnitude of groundwater flow can be estimated based on these mean groundwater elevations. Calculations of the magnitude of flow are included in Appendix A. The evaluation of flow in the vicinity of the slurry wall indicates that there are three main components of flow from within the barrier wall near PZ-105S as shown on Figure 7-1. These three flow components include:

- Flow through the low permeability slurry wall (approximately 0.1 ft^3/day)
- Flow under the wall through the lower permeability estuarine unit (approximately 1 ft^3/day)
- Flow from within the wall, around the southeastern end of the wall (approximately 10 ft^3/day).

Flow through and below the wall are both very low and similar to that expected during wall design. However, the third component of flow, flow around the southeastern end of the wall, was not expected during design. This flow is a result of the unanticipated change in general groundwater flow direction in the area.

The flow around the southeastern end of the wall is relatively small since it is essentially driven by surface recharge within the wall through the low permeability cap. Limited recharge is suggested by PZ-105, which has a consistent water level during both the fall and spring (9.00 and 9.06 feet, respectively). As indicated on Figure 7-1, this component of flow around the southern end of the wall would occur in the vicinity of RW-12S. Monitoring well RW-12S is sampled quarterly as a part of the confirmational monitoring program. All concentrations detected have been well below the ACL and no increasing trend has been noted. Monitoring at this well will continue and trends will continue to be tracked as part of the confirmational monitoring program specified in the ROD for the site.

Groundwater level measurements across the southern opening of the wall also suggest flow to the northeast. Flow through this area could potentially carry dissolved constituents from the process area northeastward, south of the eastern end of the slurry wall. However, the gradients that drive this flow across the southeastern end of the wall are very low, and for the eastern wells are essentially at measurement error. For example, water level measurements in piezometers PZ-B, PZ-C and CMP-15 were 8.15, 8.13, and 8.17, respectively. This limited variation occurs across a horizontal distance of approximately 600 feet.

The potential for impacts associated with this northeastward groundwater flow across the process area was reviewed. Groundwater concentrations from monitoring wells around or near the process area from sampling during the RI/FS phase were reviewed. Several of the wells exceeded the ROD specified ACL for benzo(g,h,i)perylene; however as discussed in Section 7.1.2 concentrations of benzo(g,h,i)perylene above the ROD specified ACL are still protective. For the other constituents, ten monitoring wells were sampled (see Figure 7-2) and, only one well (W-8) had concentrations that exceeded the ACLs. Concentrations of 6 PAHs exceeded the ACL by an order of magnitude or less. Well W-8 is located upgradient of well RW-12. As indicated above, groundwater in this vicinity is monitored quarterly, concentrations are compared to ACLs and the data is reviewed for any increasing trends. No concentrations exceed the ACL and no increasing trends have been noted.

The existing data indicate that the slurry wall is continuing to meet its objectives despite the approximately 90-degree shift in groundwater flow direction. The volume of flow through and beneath the slurry wall is very limited and similar to flows expected during the design process. Some limited flow is occurring around the southeast edge of the wall. Groundwater quality in this area is monitored by well RW-12S on a quarterly basis. Current groundwater monitoring data indicate that this limited flow around the southeastern end of the wall is not causing increased groundwater concentrations. Monitoring will continue on a quarterly basis.

7.1.5 Institutional Controls

The land and groundwater uses have not changed and as stated in the ROD the early actions will remain protective if the uses are unchanged. The ROD requires restrictions on land use and prohibits the use of groundwater.

7.1.6 Shoreline Seep Observations

NAPL seeps at the shoreline were observed prior to construction of the barrier wall during low tide. Since construction of the slurry wall the seeps have only been observed immediately after the 2001 Nisqually Earthquake. After the earthquake, the shoreline was inspected for potential NAPL seeps.

Ground motion associated with significant earthquakes can cause subsurface disturbances such as ground liquefaction and lateral ground spreading in areas with loose soil (such as fill areas) and high groundwater table, or in areas near shorelines. Temporary sheening can result due to the release of previously immobile impacted pore fluid from the near shore soils when the soils are disturbed by earthquake ground shaking. Such temporary sheening is expected to stop shortly after the ground disturbance. Therefore, the shoreline was inspected for potential NAPL seeps after the Nisqually Earthquake.

Only two areas of minor sheening were noted after the Nisqually Earthquake. Both areas of NAPL observed correspond to seep areas previously documented in 1994, at the shoreline northeast of the MW-5 monitoring well cluster and at the shoreline west or RW-1. The sheening was absent in additional inspections during the months following the earthquake. In general, the Early Actions have caused the shoreline sheens to cease. The exception may be the temporary reappearance of sheens during infrequent large earthquakes.

7.1.7 Measurements of Groundwater Discharge to Sediment

Results from design work on the MSU have provided additional support that the remedy is functioning. Measurements were made of the groundwater discharge rate throughout the MSU at varying depths and locations for the sediments cap design process. These results are pertinent to the effectiveness of the groundwater remedy as the measured groundwater discharge rate was substantially less than the estimated rate in the modeling effort used to calculate the ACLs for groundwater.

The groundwater velocities calculated during the MSU work ranged from 0.000202 ft/day (net discharge of groundwater to sediment) to –0.000201 ft/day (net recharge of seawater into sediments). These numbers are three to four orders of magnitude smaller than the groundwater velocities used in calculating the groundwater ACLs for the upland wells. (Groundwater velocities of 4.48 ft/day for shallow wells, 0.62 ft/day for intermediate wells, and 0.14 ft/day for deep wells were used in developing the ACL.)

Additional information on the groundwater velocities measured during the MSU work is available in the *Draft Technical Memorandum #1, Pre-Design Investigation Summary* (URS, 2002).

7.1.8 Nisqually Earthquake

The Nisqually earthquake occurred on February 28, 2001 and was a magnitude 6.8 earthquake. Evidence of earthquake-induced ground motion was noted at the site. Ground cracking and damage to some of the monitoring wells were noted.

Due to the ground motion, concerns were raised regarding the integrity of the slurry wall. An assessment of the integrity of the slurry wall was conducted through a tidal study, as direct observation of the slurry wall is not feasible. These results are detailed in the *Post Earthquake Slurry Wall Performance*

Assessment (RETEC, 2002). Ten piezometers, one shallow and one deep, were installed at five separate locations upgradient of the slurry wall were installed. Transducers were placed inside the piezometers and water levels were measured over a 24-hour period. Tidal efficiencies and tidal fluctuations were calculated and compared to past data and design criteria. Results showed the slurry wall function after the earthquake was similar to the function prior to the earthquake. The conclusion of the assessment was that the wall was continuing to effectively contain shallow groundwater and NAPL.

Surface cracking in the cap was discussed in Section 7.1.1. All cracks were less than a half-inch across and were sealed.

Several site monitoring wells showed movement and some showed damage. The site monitoring wells were surveyed, inspected, redeveloped, and sampled as necessary to confirm their condition and usability for future site work. Seven wells were determined to be damaged. Of the seven damaged wells, two were repaired and three were abandoned and replaced. The other two wells were initially intended for use in the DNAPL monitoring program however the wells no longer produced DNAPL so these wells were abandoned and not replaced. The repair, abandonment, and installation work was completed by the summer of 2003.

7.2 Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Still Valid?

Site conditions and use are as expected in the RI/FS and ROD. The site continues to be used for industrial purposes, as a marine terminal. The cap is maintained and the RAOs are still valid. In the five years since the ROD, toxicity data and cleanup levels have not changed; however, the ACLs were not appropriately calculated and need to be revisited. In any case, groundwater concentrations have exceeded the ROD specified ACLs in some instances, but the remedy is still protective of human health and the environment.

7.3 New Information

No other information has come to light that would call into question the protectiveness of the remedy. No new ecological risks were found and no land use changes are being considered. The only natural disaster to have occurred since the early remedial actions was the 2001 Nisqually Earthquake. Assessments conducted after this earthquake showed that the remedy continues to function as designed.

The MSU remedial action was initiated in August 2004. The remedy includes capping 58 acres of contaminated marine sediments. Seventeen acres of that cap were placed by February 2005. The remaining 41 acres of capping will be completed by February 2006.

8 Issues

Below are the issues that were identified during the Five Year Review.

Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
COCs have exceeded the ACLs during the first year of confirmational sampling. Ongoing multiple exceedances have been detected for benzo(g,h,i)perylene in several wells and pentachlorophenol in MW-14S. Naphthalene concentrations in MW-14I have been confirmed above the ACL, but have decreased after well development.	N	N
DNAPL has accumulated in one of the wells intended for confirmational groundwater monitoring (MW-13I).	N	N
Not all of the institutional controls have been implemented (deed restrictions).	N	Possibly

Section 7.1.2 provides further discussion on why the detected groundwater concentrations do not and will not affect the protectiveness. DNAPL in well MW-13I does not affect protectiveness. Concentrations in this well prior to the accumulation of DNAPL were below ACLs with the exception of benzo(g,h,i)perylene. This well diminishes the density of the monitoring network in the vicinity of MW-13I, but does not alter protectiveness. With regard to institutional controls, deed restrictions are in the process of being placed on the property. The lack of deed restrictions does not currently affect the protectiveness. Use of groundwater continues to be prevented by City of Seattle Code, and the Port continues to appropriately manage the property with the cooperation of the current tenant, APL. Lack of deed restrictions could possibly alter protectiveness in the future should City of Seattle Code change, or the property management change.

9 Recommendations and Follow-up Actions

Issue	Recommendations and Follow-Up Actions	Party Responsible	Oversight Agency	Mile-stone Date
Groundwater concentrations detected above the ACLs	a. Continue monitoring quarterly to collect sufficient data to complete seasonality analysis. b. If no seasonality is present, a trend analysis will be conducted. c. If seasonality is present, conduct additional groundwater monitoring and complete trend analysis	Port of Seattle through 2005 (as a reimbusable expense under the SAOC and PPA) [1]	EPA	a. April 2006 [2] b. July 2006 c. July 2009
The ACLs were not appropriately calculated	EPA will determine next steps	EPA	EPA	December 2006
DNAPL accumulation in monitoring well	a. Try to collect a representative groundwater sample from this well b. Determine next appropriate steps for groundwater monitoring based on the results (e.g., install replacement well or use other existing well for groundwater monitoring)	Port of Seattle through 2005 (as a reimbusable expense under the SAOC and PPA)	EPA	a. November 2004 b. January 2005
Lack of complete institutional control	Record land and groundwater use restrictions against the deed and ensure restrictive covenants are in place	Port of Seattle for Port owned property and State of Washington for State-owned property [3]	EPA	December 2004 for Port owned property October 2006 for State owned property

Note:

[1] The SAOC only addresses 2 to 3 years of groundwater monitoring. The party responsible for monitoring after 2005 has not yet been determined.

[2] The results of the seasonality analysis will be reported immediately to the EPA in order to allow for preparation of continued monitoring.

[3] The EPA expects the institutional controls for the State owned property to be part of the State Superfund Contract.

10 Protectiveness Statement

The remedy for the Upland Groundwater Unit is protective of human health and the environment. Confirmational sampling will continue and institutional controls will be put in place within the next year to assure protectiveness in the future.

The remedy for the MSU is expected to be protective of human health and the environmental on completion.

11 Next Review

The next five-year review for the PSR site is required by September 30, 2009, five years from the date of this review. Both the MSU and the Upland Groundwater Unit will be addressed in the next review.

12 References

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Tables

Table 7-1 Alternate Concentration Limits

	ACLs (μg/L)	
	Shallow Wells (9 to -6 ft MLLW)	Intermediate Wells (-20 to -40 ft MLLW)
Naphthalene	>S	7,700
Acenaphthylene	3,300	700
Acenaphthene	>S	>S
Fluorine	930	200
Phenanthrene	>S	400
Anthracene	>S	900
Fluoranthene	>S	100
Pyrene	>S	>S
Benzo(a)anthracene	>S	3.0
Chrysene	>S	3.0
Benzo(b)fluoranthene	>S	>S
Benzo(k)fluoranthene	>S	3.0
Benzo(a)pyrene	>S	3.0
Indeno(1,2,3-cd)pyrene	0.47	0.1
Dibenzo(a,h)anthracene	>S	>S
Benzo(g,h,I)perylene	0.09	0.016
Dibenzofuran	880	190
Pentachlorophenol	2,300	490
Zinc	36,000	7,700

Note:
The calculated concentrations reported in the table do not result in cleanup levels being exceeded at the mudline. Values correspond to the shortest distance to the mudline for the shallow, intermediate and deep zones. "S" indicates that concentrations in excess of the individual constituent solubility level in water are required to exceed cleanup levels at the mudline.

Table 7-2 Groundwater Quality in Shallow Monitoring Wells

Location ID		MW-3S						MW-11S				
Sample ID		MW-3S-0503	MW-3S-0903	MW-3S-1103	MW-103S-1103	MW-3S-0204	MW-3S-0504	MW-11S-0503	MW-11S-0903	MW-11S-1103	MW-11S-0204	MW-11S-0504
Sample Date		05/23/03	09/08/03	11/25/03	11/25/03	02/26/04	05/20/04	05/24/03	09/09/03	11/24/03	02/24/04	05/19/04
Chemical Name (µg/L)												
2-Methylnaphthalene	NA	**0.0054 J**	0.0047 U	0.0028 U	0.0027 U	**0.012 J**	**0.0035 J**	0.020 U	0.012 U	0.019 U	0.020 U	0.020 U
Acenaphthene	>S	**0.0039 J**	**0.0030 J**	0.019 U	**0.0025 J**	**0.0069 J**	**0.0052 J**	0.020 U	0.020 U	0.019 U	0.020 U	0.020 U
Acenaphthylene	3300	**0.0019 J**	0.020 U	0.019 U	0.019 U	0.020 U	**0.0032 J**	0.020 U	0.020 U	0.019 U	0.020 U	**0.0027 J**
Anthracene	>S	**0.0093 J**	**0.010 J**	**0.011 J**	**0.011 J**	**0.018 J**	**0.03**	**0.011 J**	**0.033**	**0.011 J**	**0.014 J**	**0.06**
Benzo(a)anthracene	>S	0.020 U	0.020 U	0.019 U	0.019 U	**0.0049 J**	0.020 U	**0.0021 J**	0.020 U	**0.0041 J**	**0.0022 J**	0.020 U
Benzo(a)pyrene	>S	0.0018 U	0.020 U	0.019 U	0.019 U	**0.0026 J**	0.020 U	0.020 U	0.020 U	**0.0060 J**	**0.0021 J**	0.020 U
Benzo(b)fluoranthene	>S	0.020 U	0.020 U	0.019 U	0.019 U	**0.0049 J**	0.020 U	**0.0028 J**	0.020 U	**0.0084 J**	**0.0041 J**	0.020 U
Benzo(g,h,i)perylene	(0.09)(>S)	0.020 U	0.020 U	**0.018 J**	0.019 U	**0.0050 J**	0.020 U	0.020 U	0.020 U	**0.0064 J**	0.020 U	0.020 U
Benzo(k)fluoranthene	14	0.0014 U	0.020 U	0.019 U	0.019 U	**0.0031 J**	0.020 U	0.0024 U	0.020 U	**0.0055 J**	**0.0031 J**	0.020 U
Chrysene	>S	**0.0019 J**	0.020 U	0.019 U	0.019 U	**0.0034 J**	**0.0023 J**	**0.0030 J**	**0.0016 J**	**0.0059 J**	**0.0033 J**	0.020 U
Dibenz(a,h)anthracene	>S	0.0022 U	0.020 U	**0.012 J**	0.019 U	**0.0018 J**	0.020 U	0.020 U	0.020 U	0.019 U	0.020 U	0.020 U
Dibenzofuran	880	0.020 U	0.020 U	0.019 U	0.019 U	0.020 U	0.020 U	0.020 U	0.020 U	0.019 U	0.020 U	0.020 U
Fluoranthene	>S	**0.0050 J**	**0.0026 J**	0.019 U	**0.0025 J**	0.0080 U	**0.025**	**0.0052 J**	0.020 U	**0.0081 J**	0.0050 U	0.020 U
Fluorene	930	**0.0032 J**	0.020 U	0.019 U	0.019 U	**0.0077 J**	**0.0080 J**	0.020 U	0.020 U	0.019 U	0.020 U	0.020 U
Indeno(1,2,3-cd)pyren	0.47	0.0029 U	0.020 UJ	**0.015 J**	0.019 U	**0.0043 J**	0.020 U	0.0024 U	0.020 UJ	0.0086 U	**0.0021 J**	0.020 U
Naphthalene	>S	0.0080 U	0.013 U	0.0062 U	0.019 U	**0.033**	0.014 U	0.017 U	0.032 U	0.0090 U	0.0068 U	0.0042 U
Pentachlorophenol	2,300	2.0 UJ	0.96 UJ	0.94 UJ	0.95 UJ	0.49 U	0.62 U	2.0 UJ	0.97 UJ	0.95 UJ	0.47 U	0.36 U
Phenanthrene	>S	**0.0083 J**	**0.0043 J**	**0.0037 J**	**0.0049 J**	0.015 U	**0.025**	**0.0033 J**	**0.0033 J**	**0.0035 J**	0.0043 U	0.020 U
Pyrene	>S	**0.0086 J**	**0.0071 J**	**0.012 J**	**0.011 J**	**0.011 J**	**0.020 J**	**0.0032 J**	0.020 U	**0.0072 J**	**0.0041 J**	0.020 U
Zinc	36,000	10 U	10.0 U	10 U	**10.5**	**5.4 B**	10 U	**8.3 B**	**2.1 B**	**7.7 B**	**3.2 B**	10 U

Notes:
For benzo(g,h,i)perylene, two ACLs are indicated as follows: (ROD-specified) (draft revised ACL).
S - Concentrations in excess of the individual compound solubility concentration in water are required to exceed cleanup levels at the mudline.
Bold - detection
Shading - Concentration exceeds ROD-specified ACL
Italics - There was no detection above the method reporting limit (MRL); however the MRL is greater than the ROD-specified ACL
See Figure 4-2 to locate wells

Table 7-2 Groundwater Quality in Shallow Monitoring Wells

Location ID		MW-14S						MW-15-SR				
Sample ID		MW-14S-0503	MW-14S-0903	MW-14I-1103	MW-14S-0204	Duplicate1-0204	MW-14S-0504	MW-15-SR-0503	MW-15SR-0903	MW-15SR-1103	MW-15SR-0204	MW-15SR-0504
Sample Date		05/23/03	09/08/03	11/26/03	02/25/04	02/25/04	05/20/04	05/24/03	09/09/03	11/24/03	02/25/04	05/19/04
Chemical Name (µg/L)												
2-Methylnaphthalene	NA	**350**	**590**	**390**	**320 J**	**310 J**	**280**	**10**	**9**	**0.036**	**1.8**	**0.26**
Acenaphthene	>S	**290**	**290**	**440**	**400 J**	**390 J**	**330**	**52**	**68**	**53**	**39 J**	**14**
Acenaphthylene	3300	**9.2**	**7.3**	**11**	**8.4 J**	**8.2 J**	**9.3**	**0.48**	**0.65**	**0.56**	**0.7**	**0.15**
Anthracene	>S	**23**	**4.3**	**30**	**21 J**	**21 J**	**22**	**8.7**	**7.1**	**6**	**9.9**	**2.7**
Benzo(a)anthracene	>S	**0.90 J**	**0.22**	**0.92**	**0.57 J**	**0.65 J**	**0.44**	**0.95**	**0.59**	**0.42**	**2.4**	**0.15**
Benzo(a)pyrene	>S	**0.21 J**	**0.19 J**	**0.23**	**0.18 J**	**0.21 J**	**0.11 J**	**0.21**	**0.15 J**	**0.06**	**0.9**	**0.019 J**
Benzo(b)fluoranthene	>S	**0.28 J**	**0.063 J**	**0.27**	**0.25 J**	**0.29 J**	**0.16 J**	**0.29**	**0.2**	**0.075**	**1.2**	**0.027**
Benzo(g,h,i)perylene	(0.09)(>S)	**0.031 J**	*0.20 U*	**0.052 J**	**0.11 J**	**0.13 J**	**0.053 J**	**0.033**	**0.042 J**	**0.0079 J**	**0.2**	0.020 U
Benzo(k)fluoranthene	14	**0.24 J**	**0.033 J**	**0.19**	**0.18 J**	**0.23 J**	**0.14 J**	**0.2**	**0.14 J**	**0.043**	**0.93**	**0.012 J**
Chrysene	>S	**0.85 J**	**0.19 J**	**0.73**	**0.56 J**	**0.71 J**	**0.43**	**0.9**	**0.71**	**0.29**	**2.7**	**0.13**
Dibenz(a,h)anthracene	>S	0.017 U	0.20 U	0.19 U	**0.091 J**	**0.11 J**	0.20 U	0.014 U	**0.021 J**	**0.0028 J**	**0.09**	**0.0035 J**
Dibenzofuran	880	**160**	**170**	**240**	**160 J**	**160 J**	**200**	**33**	**43**	**31**	**22 J**	**6.5**
Fluoranthene	>S	**13**	**8.2**	**16**	**12 J**	**12 J**	**12**	**12**	**12**	**7.7**	**17**	**2.9**
Fluorene	930	**130**	**93**	**200**	**160 J**	**160 J**	**150**	**39**	**44**	**33**	**29 J**	**5.6**
Indeno(1,2,3-cd)pyren	0.47	**0.057 J**	**0.032 J**	**0.077 J**	**0.13 J**	**0.14 J**	**0.074 J**	**0.057**	**0.067 J**	**0.012 J**	**0.29**	**0.0059 J**
Naphthalene	>S	**4300**	**9000**	**5900**	**5200 J**	**5200 J**	**5000**	**46**	**310**	**5.5**	**17**	**1.6**
Pentachlorophenol	2,300	**3200 J**	**42 J**	**2500 J**	**2700 J**	**2600 J**	**2200**	2.0 UJ	**3.2 J**	0.95 UJ	**310 J**	**34 J**
Phenanthrene	>S	**100**	**120**	**140**	**130 J**	**130 J**	**93**	**44**	**50**	**25**	**36 J**	**5.6**
Pyrene	>S	**8.3**	**3.4**	**9.8**	**7.9 J**	**8.0 J**	**6.2**	**7.2**	**5**	**4.4**	**14**	**1.6**
Zinc	36,000	**12.5**	10.0 U	**445**	**19.4**	**17.2**	**27.9**	**7.5 B**	10.0 U	10 U	**2.2 B**	10 U

Notes:
For benzo(g,h,i)perylene, two ACLs are indicated as follows: (ROD-specified) (draft revised ACL).
S - Concentrations in excess of the individual compound solubility concentration in water are required to exceed cleanup levels at the mudline.
Bold - detection
Shading - Concentration exceeds ROD-specified ACL
Italics - There was no detection above the method reporting limit (MRL); however the MRL is greater than the ROD-specified ACL
See Figure 4-2 to locate wells

Table 7-2 Groundwater Quality in Shallow Monitoring Wells

	Location ID	RW-1S						RW-6SR					RW-12S				
	Sample ID	RW-1S-0503	RW-1S-0903	RW-1S-1103	RW-1S-0204	RW-1S-0504	RW-100S0504	RW-6SR-0503	RW-6SR-0903	RW-6SR-1103	RW-6SR-0204	RW-6SR-0504	RW-12S-0503	RW-12S-0903	RW-12S-1103	RW-12S-0204	RW-12S0504
Chemical Name (µg/L)	Sample Date	05/23/03	09/08/03	11/25/03	02/26/04	05/20/04	05/20/04	05/28/03	09/08/03	11/25/03	02/25/04	05/20/04	05/28/03	09/09/03	11/24/03	02/25/04	05/20/04
2-Methylnaphthalene	NA	**11**	**5.7**	**3.6 J**	**0.59 J**	**6.8**	**5.9**	**0.17**	**0.073**	0.013 U	**0.019 J**	**0.018 J**	**0.1**	**0.18**	0.010 U	**0.016 J**	**0.11**
Acenaphthene	>S	**270**	**370**	**360 J**	**290 J**	**300**	**280**	**1.3**	**0.74**	**0.44**	**1.1**	**0.97**	**0.63**	**0.97**	**0.29**	**0.6**	**0.91**
Acenaphthylene	3300	**6.1**	**4.6**	**8.8 J**	**6.4 J**	**6**	**6.2**	**0.021**	**0.022**	**0.018 J**	**0.019 J**	**0.02**	**0.05**	**0.1**	**0.012 J**	**0.018 J**	**0.080**
Anthracene	>S	**8**	**14**	**14 J**	**9.2 J**	**8.7**	**9.7**	**0.18**	**0.18**	**0.14**	**0.15**	**0.27**	**0.16**	**0.43**	**0.12**	**0.21**	**0.75**
Benzo(a)anthracene	>S	**0.50 J**	**0.88**	**1.2 J**	**1.2 J**	**0.43**	**0.46**	**0.024**	**0.025**	**0.026**	**0.018 J**	**0.012 J**	**0.061**	**0.08**	**0.06**	**0.068**	**0.081**
Benzo(a)pyrene	>S	**0.16 J**	**0.49**	**0.50 J**	**0.55 J**	**0.14 J**	**0.15 J**	0.0095 U	**0.012 J**	**0.0074 J**	**0.0039 J**	**0.0017 J**	0.012 U	**0.011 J**	**0.0039 J**	**0.0061 J**	**0.013 J**
Benzo(b)fluoranthene	>S	**0.23 J**	**0.39**	**0.53 J**	**0.62 J**	**0.18 J**	**0.19 J**	0.010 U	**0.011 J**	**0.0069 J**	**0.0083 J**	**0.0026 J**	**0.021**	**0.018 J**	**0.010 J**	**0.016 J**	**0.015 J**
Benzo(g,h,i)perylene	(0.09)(>S)	**0.065 J**	**0.24**	**0.19 J**	**0.44 J**	**0.054 J**	**0.048 J**	0.0070 U	**0.0082 J**	**0.0047 J**	0.023 U	0.020 U	0.010 U	**0.0054 J**	0.019 U	0.020 U	0.020 U
Benzo(k)fluoranthene	14	**0.15 J**	**0.5**	**0.39 J**	**0.48 J**	**0.073 J**	**0.12 J**	0.0093 U	**0.0094 J**	**0.0048 J**	**0.0072 J**	**0.0017 J**	0.012 U	**0.014 J**	**0.0044 J**	**0.011 J**	**0.013 J**
Chrysene	>S	**0.30 J**	**0.71**	**0.81 J**	**1.0 J**	**0.28**	**0.33**	**0.03**	**0.03**	**0.029**	**0.023 J**	**0.011 J**	**0.07**	**0.081**	**0.055**	**0.068**	**0.070**
Dibenz(a,h)anthracene	>S	0.019 U	**0.095 J**	**0.048 J**	**0.10 J**	0.20 U	0.20 U	0.0023 U	0.020 U	0.019 U	0.023 U	0.020 U	0.0053 U	0.020 U	0.019 U	0.020 U	0.020 U
Dibenzofuran	880	**86**	**180**	**130 J**	**100 J**	**83**	**83**	**0.18**	**0.14**	**0.078**	**0.23**	**0.26**	**0.028**	**0.057**	**0.014 J**	**0.018 J**	**0.041**
Fluoranthene	>S	**14**	**20**	**24 J**	**21 J**	**18**	**18**	**0.23**	**0.29**	**0.37**	**0.22**	**0.15**	**0.86**	**1.4**	**0.77**	**1.1**	**1.3**
Fluorene	930	**93**	**170**	**130 J**	**130 J**	**77**	**79**	**0.44**	**0.25**	**0.11**	**0.35**	**0.28**	**0.23**	**0.36**	**0.11**	**0.23**	**0.35**
Indeno(1,2,3-cd)pyrene	0.47	**0.10 J**	**0.3**	**0.27 J**	**0.51 J**	**0.090 J**	**0.064 J**	0.0071 U	**0.0090 J**	0.0049 U	**0.0035 J**	0.020 U	0.011 U	**0.0049 J**	0.019 U	**0.0038 J**	0.020 U
Naphthalene	>S	**1100**	**1200**	**810 J**	**180 J**	**740**	**670**	**4.5**	**1.3**	**0.25**	**1.2**	**1.9**	**4.6**	**7.5**	**0.52**	**0.79**	**4.7**
Pentachlorophenol	2,300	**430 J**	**220 J**	**93 J**	**22 J**	**220 J**	**250 J**	2.0 UJ	0.96 UJ	0.94 UJ	0.58 U	0.69 U	2.0 UJ	**0.45 J**	0.95 UJ	0.49 U	0.48 U
Phenanthrene	>S	**52**	**140**	**63 J**	**48 J**	**33**	**35**	**0.5**	**0.4**	**0.11**	**0.1**	**0.039**	**0.067**	**0.11**	**0.016 J**	**0.043**	**0.10**
Pyrene	>S	**7.2**	**9.7**	**15 J**	**13 J**	**8.9**	**9.1**	**0.28**	**0.25**	**0.39**	**0.27**	**0.16**	**0.79**	**0.96**	**0.65**	**1**	**1.0**
Zinc	36,000	**2 B**	**12.6**	**8.7 B**	**3.2 B**	6.5 U	2.8 U	10.0 U	**2.1 B**	**2.7 B**	10 U	2.8 U	10.0 U	10.0 U	**2.2 B**	10 U	10 U

Notes:
For benzo(g,h,i)perylene, two ACLs are indicated as follows: (ROD-specified) (draft revised ACL).
S - Concentrations in excess of the individual compound solubility concentration in water are required to exceed cleanup levels at the mudline.
Bold - detection
Shading - Concentration exceeds ROD-specified ACL
Italics - There was no detection above the method reporting limit (MRL); however the MRL is greater than the ROD-specified ACL
See Figure 4-2 to locate wells

Table 7-3 Groundwater Quality in Intermediate Monitoring Wells

Chemical Name (µg/L)	Location ID / Sample ID / Sample Date	MW-3I					MW-11IR				MW-13I
		MW-3I-0503 05/23/03	MW-3I-0903 09/08/03	MW-3I-1103 11/25/03	MW-3I-0204 02/26/04	MW-3I-0504 05/20/04	MW-11IR-0903 09/09/03	MW-11IR-1103 11/25/03	MW-11IR-0204 02/25/04	MW-11IR-0504 05/19/04	MW-13I-0503 05/23/03
2-Methylnaphthalene	NA	**0.026**	**0.016 J**	0.0095 U	**0.034**	**0.016 J**	**0.19**	**0.69**	**3.1**	0.020 U	**420**
Acenaphthene	>S	**0.016 J**	**0.054**	**0.034**	**0.026**	**0.030**	**80**	**57**	**87**	**0.48**	**220**
Acenaphthylene	3,300	**0.02**	**0.076**	**0.1**	**0.0072 J**	**0.017 J**	**2.8**	**1.3**	**1**	**0.051**	**7.1**
Anthracene	900	**0.016 J**	**0.1**	**0.1**	**0.035**	**0.080**	**5.3 J**	**0.88**	**2.6**	**0.26**	**11**
Benzo(a)anthracene	>S	**0.011 J**	**0.011 J**	**0.017 J**	**0.016 J**	**0.019 J**	**1.1**	**0.63**	**0.65**	**0.22**	**0.41**
Benzo(a)pyrene	3.0	0.0054 U	**0.0027 J**	**0.0059 J**	**0.0031 J**	**0.0057 J**	**0.2**	**0.1**	**0.052**	**0.083**	**0.074 J**
Benzo(b)fluoranthene	>S	**0.0060 J**	**0.0053 J**	**0.0080 J**	**0.0068 J**	**0.010 J**	**0.25**	**0.14**	**0.1**	**0.12**	**0.094 J**
Benzo(g,h,i)perylene	(0.016)(>S)	**0.0038 J**	*0.020 U*	**0.0061 J**	*0.021 U*	*0.020 U*	**0.037**	**0.027**	**0.0087 J**	**0.013 J**	**0.025 J**
Benzo(k)fluoranthene	3.0	0.0043 U	**0.0018 J**	**0.0057 J**	**0.0034 J**	**0.0065 J**	**0.25**	**0.11**	**0.088**	**0.13**	**0.079 J**
Chrysene	3.0	**0.012 J**	**0.014 J**	**0.016 J**	**0.017 J**	**0.017 J**	**0.91**	**0.44**	**0.41**	**0.28**	**0.36**
Dibenz(a,h)anthracene	>S	0.0017 U	0.020 U	**0.0023 J**	0.021 U	0.020 U	**0.016 J**	**0.0084 J**	**0.0029 J**	**0.0035 J**	0.0087 U
Dibenzofuran	190	0.020 U	**0.013 J**	**0.010 J**	**0.012 J**	**0.016 J**	**44**	**33**	**44**	0.020 U	**130**
Fluoranthene	100	**0.052**	**0.082**	**0.072**	**0.12**	**0.11**	**23**	**14**	**21**	**2.3**	**9.2**
Fluorene	200	**0.019 J**	**0.022**	**0.024**	**0.037**	**0.039**	**60**	**29**	**61**	**0.031**	**120**
Indeno(1,2,3-cd)pyrene	0.1	0.0040 U	0.020 UJ	0.0069 U	0.021 U	**0.0026 J**	**0.056**	**0.035**	**0.011 J**	**0.016 J**	**0.027 J**
Naphthalene	7,700	**0.029**	**0.073**	**0.063**	**0.078**	**0.045**	**0.059**	**66**	**110**	0.0038 U	**4900**
Pentachlorophenol	490	2.0 UJ	0.96 UJ	0.94 UJ	0.59 U	1.7 U	0.96 UJ	0.95 UJ	0.51 U	1.4 U	**24 J**
Phenanthrene	400	**0.046**	**0.047**	**0.056**	**0.17**	**0.12**	**22**	**1.7**	**100**	**0.044**	**100**
Pyrene	>S	**0.049**	**0.083**	**0.11**	**0.13**	**0.080**	**14**	**7.4**	**14**	**0.52**	**5.2**
Zinc	7,700	**18.1**	**4.6 B**	**12.1**	**12.9**	12.1 U	**4.1 B**	**2.9 B**	10 U	10 U	**137**

Notes:
For benzo(g,h,i)perylene, two ACLs are indicated as follows: (ROD-specified) (draft revised ACL).
S - Concentrations in excess of the individual compound solubility concentration in water are required to exceed cleanup levels at the mudline.
Bold - detection
Shading - Concentration exceeds ROD-specified ACL
See Figure 4-2 to locate wells
Italics - There was no detection above the method reporting limit (MRL); however the MRL is greater than the ROD-specified ACL

Table 7-3 Groundwater Quality in Intermediate Monitoring Wells

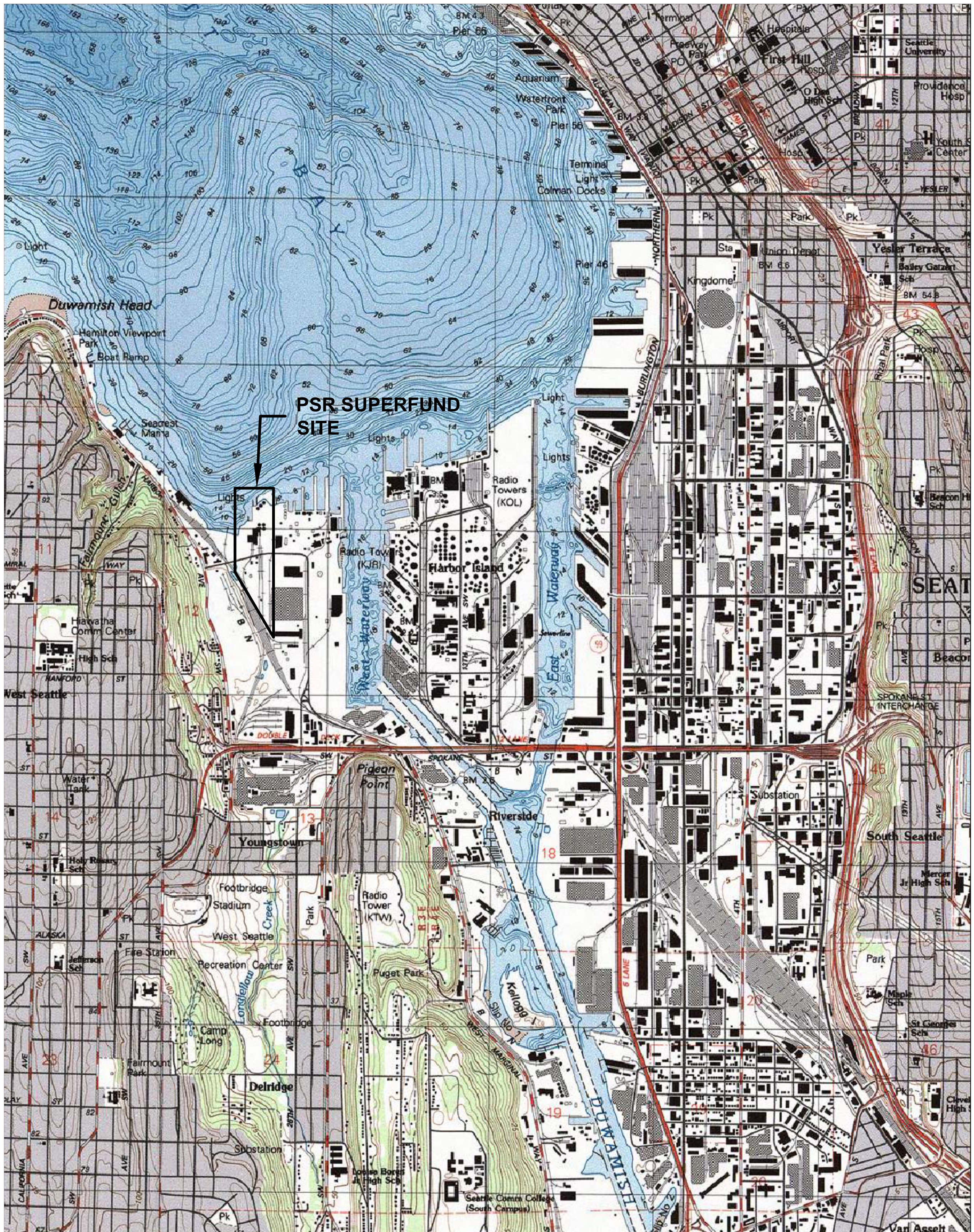
Chemical Name (µg/L)	Location ID / Sample ID / Sample Date	MW-14I						MW-15-IR				
	Sample ID	MW-14I-0503	MW-14I-0903	MW-114-0903	MW-14S-1103	MW-14I-0204	MW-14I-0504	MW-15-IR-0503	MW-15IR-0903	MW-15IR-1103	MW-15IR-0204	MW-15IR-0504
	Sample Date	05/23/03	09/08/03	09/08/03	11/26/03	02/25/04	05/20/04	05/24/03	09/09/03	11/24/03	02/25/04	05/19/04
2-Methylnaphthalene	NA	**220**	**340**	**370**	**500**	**750**	**500**	**0.063**	**230**	**180**	**370**	**190**
Acenaphthene	>S	**160**	**360**	**390**	**230**	**360**	**230**	**4.4**	**230**	**190**	**320**	**180**
Acenaphthylene	3,300	**5.3**	**9.6**	**9.1**	**5.2**	**8.3**	**5.7**	**0.12**	**2.6**	**2.9**	**3.7**	**2.4**
Anthracene	900	**14**	**15**	**15**	**5.5**	**20**	**17**	**0.21**	**8.2**	**6.8**	**11**	**7.9**
Benzo(a)anthracene	>S	**1.0 J**	**1**	**1.1**	**0.24**	**2**	**0.17 J**	**0.3**	**0.2**	**0.15**	**0.5**	**0.31**
Benzo(a)pyrene	3.0	**0.21 J**	**0.34**	**0.36**	**0.085 J**	**0.66**	**0.036 J**	**0.038**	**0.035 J**	**0.018 J**	**0.20 J**	**0.044 J**
Benzo(b)fluoranthene	>S	**0.26 J**	**0.43**	**0.45**	**0.082 J**	**0.88**	**0.042 J**	**0.081**	**0.055 J**	**0.02**	**0.22 J**	**0.060 J**
Benzo(g,h,i)perylene	(0.016)(>S)	**0.054 J**	**0.097 J**	**0.10 J**	*0.19 U*	**0.19 J**	*0.20 U*	**0.0099 J**	*0.097 U*	**0.0047 J**	**0.16 J**	*0.20 U*
Benzo(k)fluoranthene	3.0	**0.27 J**	**0.3**	**0.35**	**0.048 J**	**0.67**	**0.028 J**	**0.053**	**0.051 J**	**0.015 J**	**0.20 J**	**0.056 J**
Chrysene	3.0	**0.88 J**	**1.1**	**1.1**	**0.18 J**	**1.8**	**0.12 J**	**0.34**	**0.21**	**0.12**	**0.43**	**0.25**
Dibenz(a,h)anthracene	>S	**0.026 J**	**0.034 J**	**0.041 J**	0.19 U	**0.099 J**	0.20 U	0.0044 U	**0.0095 J**	0.019 U	**0.15 J**	0.20 U
Dibenzofuran	190	**90**	**210**	**220**	**130**	**160**	**53**	**2.1**	**160**	**98**	**130**	**72**
Fluoranthene	100	**14**	**16**	**15**	**5.1**	**20**	**9.8**	**3.8**	**8.2**	**6.1**	**14**	**8.9**
Fluorene	200	**91**	**160**	**170**	**73**	**170**	**66**	**1.7**	**130**	**97**	**150**	**74**
Indeno(1,2,3-cd)pyrene	0.1	**0.092 J**	**0.14 J**	**0.18 J**	**0.035 J**	**0.24 J**	*0.20 U*	0.014 U	**0.024 J**	0.0060 U	**0.15 J**	*0.20 U*
Naphthalene	7,700	**2500**	**5900**	**6300**	**7800**	**9800**	**7400**	**0.053**	**4000**	**3600**	**5000**	**2900**
Pentachlorophenol	490	**120 J**	**5900 J**	**5400 J**	**23 J**	**21 J**	**9.1 J**	2.0 UJ	**2.6 J**	9.5 UJ	**10 J**	**8.8 J**
Phenanthrene	400	**110**	**120**	**130**	**85**	**170**	**84**	**0.17**	**98**	**69**	**130**	**65**
Pyrene	>S	**8**	**7.6**	**7.5**	**2.4**	**13**	**3.5**	**2**	**3.7**	**3.5**	**7.7**	**4.2**
Zinc	7,700	**163**	**11.9**	**5.1 B**	**30.9**	**25.9**	3.7 U	**19.3**	10.0 U	**4.7 B**	10 U	13.1 U

Notes:
For benzo(g,h,i)perylene, two ACLs are indicated as follows: (ROD-specified) (draft revised ACL).
S - Concentrations in excess of the individual compound solubility concentration in water are required to exceed cleanup levels at the mudline.
Bold - detection
Shading - Concentration exceeds ROD-specified ACL
See Figure 4-2 to locate wells
Italics - There was no detection above the method reporting limit (MRL); however the MRL is greater than the ROD-specified ACL

Table 7-4 DNAPL Recovery Since Implementation of Confirmational Monitoring

Removal Date	MW—5I			RW—1D			RW—1I			MW—13I			Totals (gal)	**Total DNAPL Removed to Date (gal)**
	Liquid removed (gal)	DNAPL Recovered (gal)	Total DNAPL Removed to Date (gal)	Liquid removed	DNAPL Recovered (gal)	Total DNAPL Removed to Date (gal)	Liquid removed	DNAPL Recovered (gal)	Total DNAPL Removed to Date (gal)	Liquid removed	DNAPL Recovered (gal)	Total DNAPL Removed to Date (gal)		
1/14/2003	3	0.25	63.30	3	0.25	1,018.45	3	0.25	69.85	—	—	—	1	1,277.50
2/17/2003	2	0.25	63.55	3	0.25	1,018.70	2	0.25	70.1	—	—	—	1	1,278.50
3/19/2003	3.5	<0.25	63.80	3	0.25	1,018.95	3	0.25	70.35	—	—	—	1	1,279.50
5/22/2003	4	<0.25	64.05	3	<0.25	1019.2	3	<0.25	70.6	—	—	—	0.75	1,280.25
10/10/2003	3	0.5	64.55	3	1	1,020.20	3	1	71.6	3	1	1	3.5	1,283.75
11/24/2003	2	<0.25	64.80	3	0	1,020.20	2	<0.25	71.85	7	4	5	4.5	1,288.25
12/29/2003	4	0.5	65.30	3	0.25	1,020.45	3	0.25	72.1	5	4	9	5	1,293.25
1/15/2004	—	—	65.30	—	—	1,020.45	—	—	72.1	7	0.5	9.5	0.5	1,293.75
1/29/2004	—	—	65.30	—	—	1,020.45	—	—	72.1	10	1	10.5	1	1,294.75
2/5/2004	—	—	65.30	—	—	1,020.45	—	—	72.1	10	2	12.5	2	1,296.75
2/11/2004	—	—	65.30	—	—	1,020.45	—	—	72.1	4	2	14.5	2	1,298.75
2/17/2004	3	0.5	65.80	3	0.5	1,020.95	3	0.25	72.35	3	1	15.5	2.25	1,301.00
3/9/2004	—	—	65.80	—	—	1,020.95	—	—	72.35	4	1.5	17	1.5	1,302.50
4/26/2004	—	—	65.80	—	—	1,020.95	—	—	72.35	7	2	19	2	1,304.50
5/24/2004	3	0.25	66.05	4	0.5	1,021.45	2	0.25	72.6	5	2	21	3	1,307.50
6/25/2004	—	—	66.05	—	—	1,021.45	—	—	72.6	5	2.5	23.5	2.5	1,310.00
7/21/2004	—	—	66.05	—	—	1,021.45	—	—	72.6	3	1	24.5	1	1,311.00

Figures



PORT OF SEATTLE PORS1-18323-200	SITE LOCATION MAP
DATE: 08/16/04 DRWN: A.S./SEA	FIGURE 3-1

RETEC

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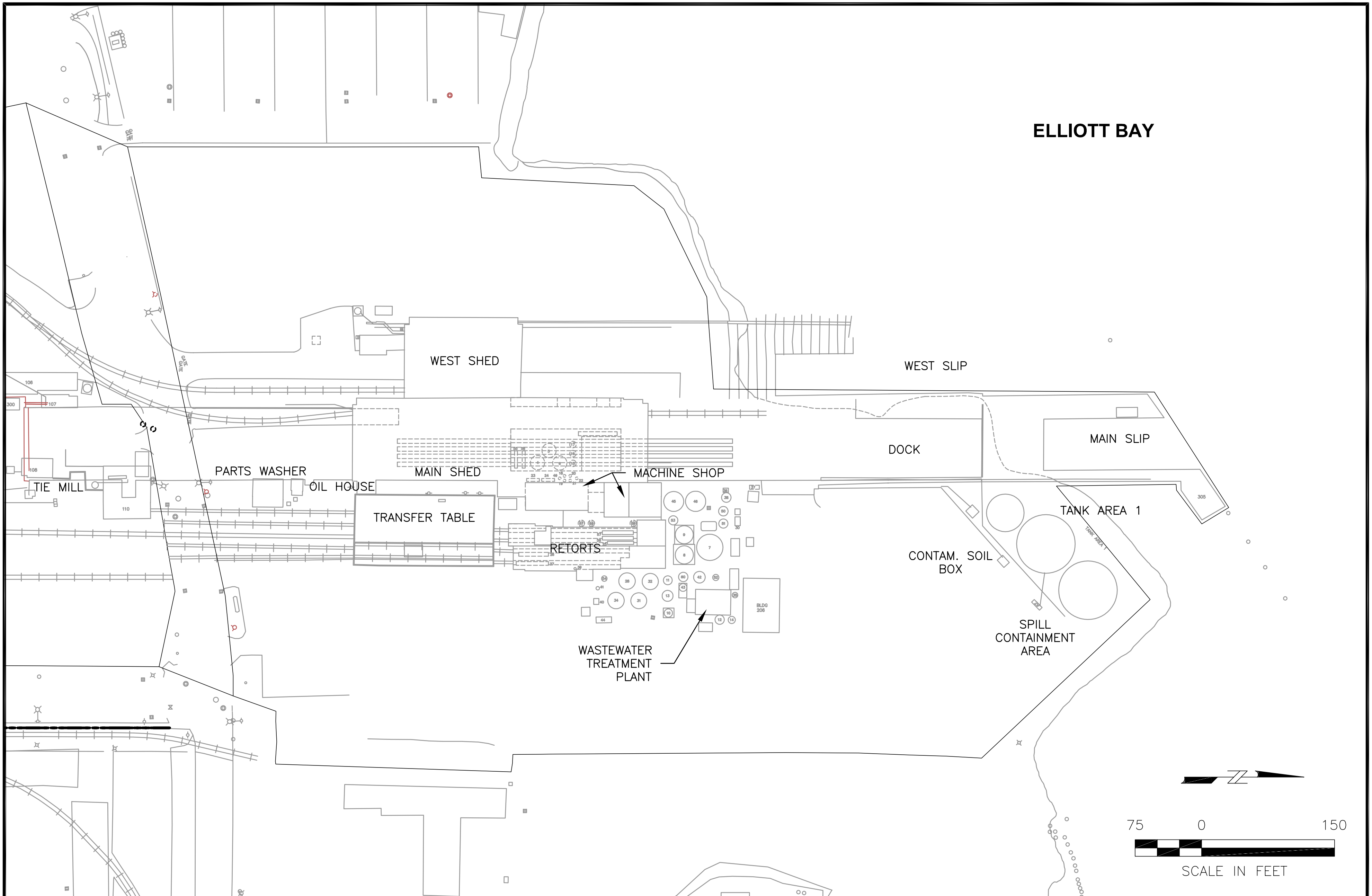


RETEC

PORT OF SEATTLE

PORS1-18323-200

DATE: 08/16/04 | DRWN: A.S./SEA

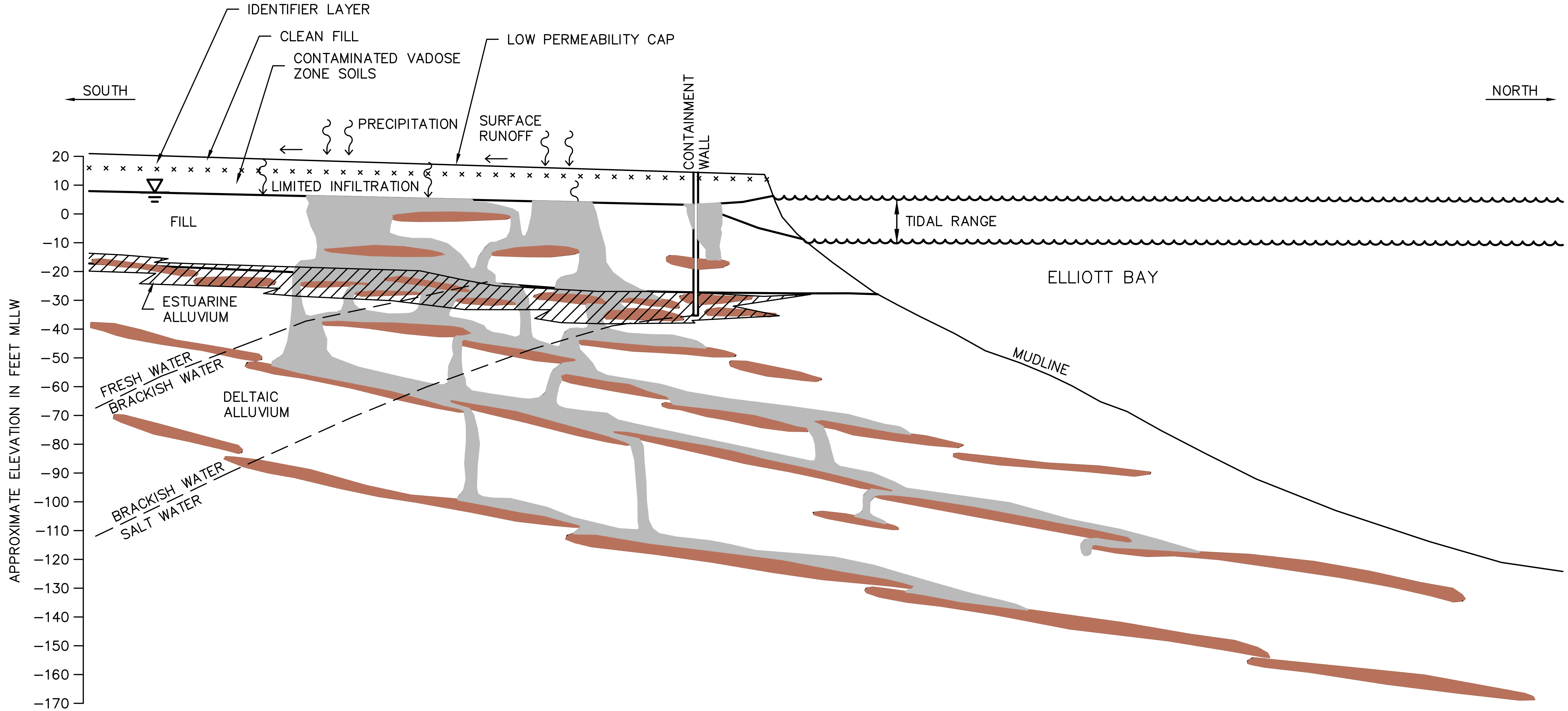
SITE LAYOUT PRIOR TO EARLY ACTIONS

PSR SUPERFUND SITE

FIGURE 3-2

RETEC

PORT OF SEATTLE PSR		TERMINAL 5-1 PRIOR TO EARLY ACTIONS
Date: 09/07/2004	File: 8323/DOCS	FIGURE 3-3



NOTES

1. SCALE AND ELEVATIONS ARE APPROXIMATE. HIGH AND LOW TIDE LEVELS AND SURFACE RELIEF ARE ESTIMATED.
2. DNAPL COULD EXTEND TO NEARSHORE SEDIMENTS IF FINE−GRAINED LAYERS EXIST THAT INHIBIT VERTICAL MIGRATION OF DNAPL AND IF SUFFICIENT DNAPL VOLUME IS PRESENT TO MIGRATE OVER LONGER DISTANCES.
3. OUTSIDE THE CONTAINMENT WALL, SALT WATER IS EXPECTED DUE TO TIDAL FLUCTUATIONS THAT WILL OVERWHELM ANY FRESHWATER FLOW.

0 50 100 200
APPROXIMATE HORIZONTAL SCALE IN FEET
VERTICAL SCALE: 1" = 40'

LEGEND

(grey)	DNAPL
(brown)	FINER−GRAINED BEDS
MLLW	MEAN LOWER LOW WATER

REFERENCE DWG	DESCRIPTION	NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE
		6							
		5							
		4							
		3							
		2							
		1							
		0	E.F.	4/8/97	INITIAL ISSUE				

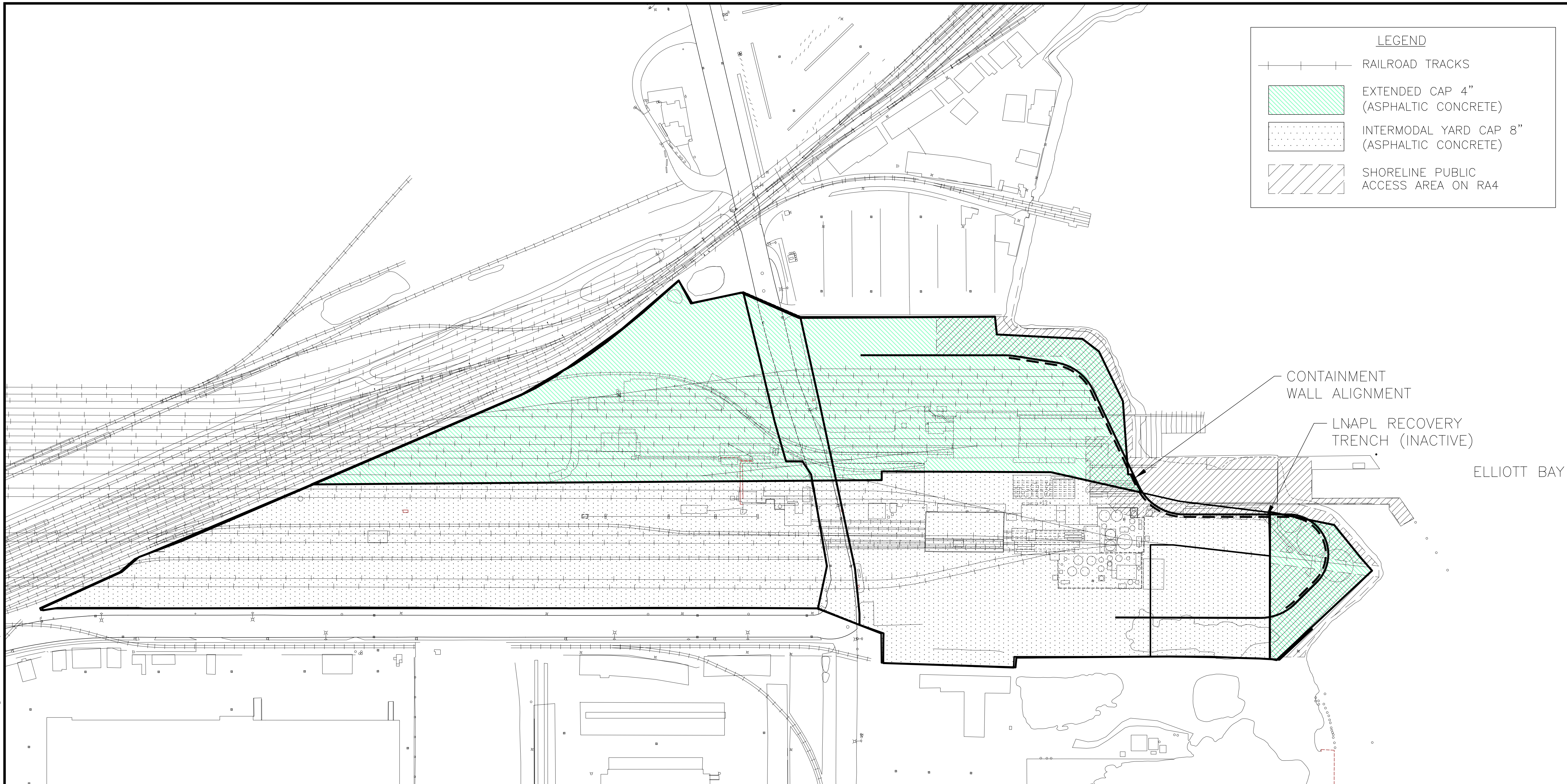
PORT OF SEATTLE
PACIFIC SOUND RESOURCES − RA4 SWHP
3−1335−560

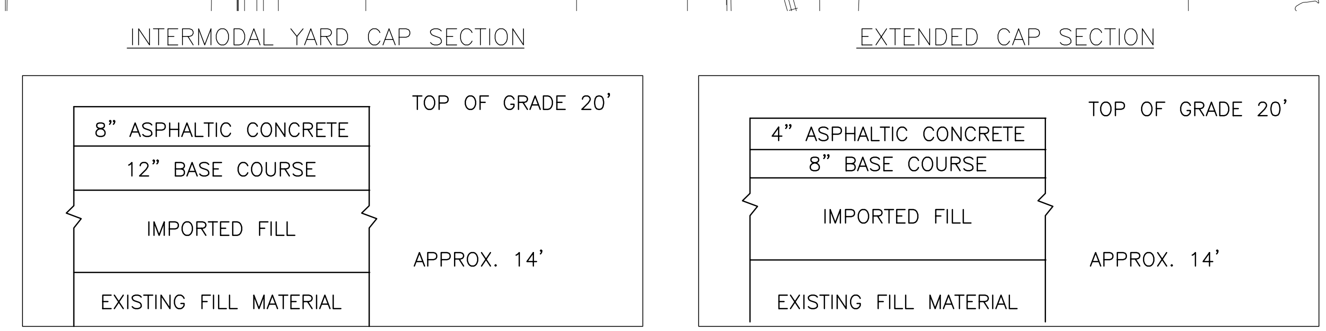
CURRENT DATE: 4/8/97 CAD FILE 1335G53S

SITE CONCEPTUAL MODEL
PACIFIC SOUND RESOURCES
SUPERFUND SITE

RETEC REMEDIATION TECHNOLOGIES INC

DRAWING NO. FIGURE 3−4 REV. 1





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PORT OF SEATTLE

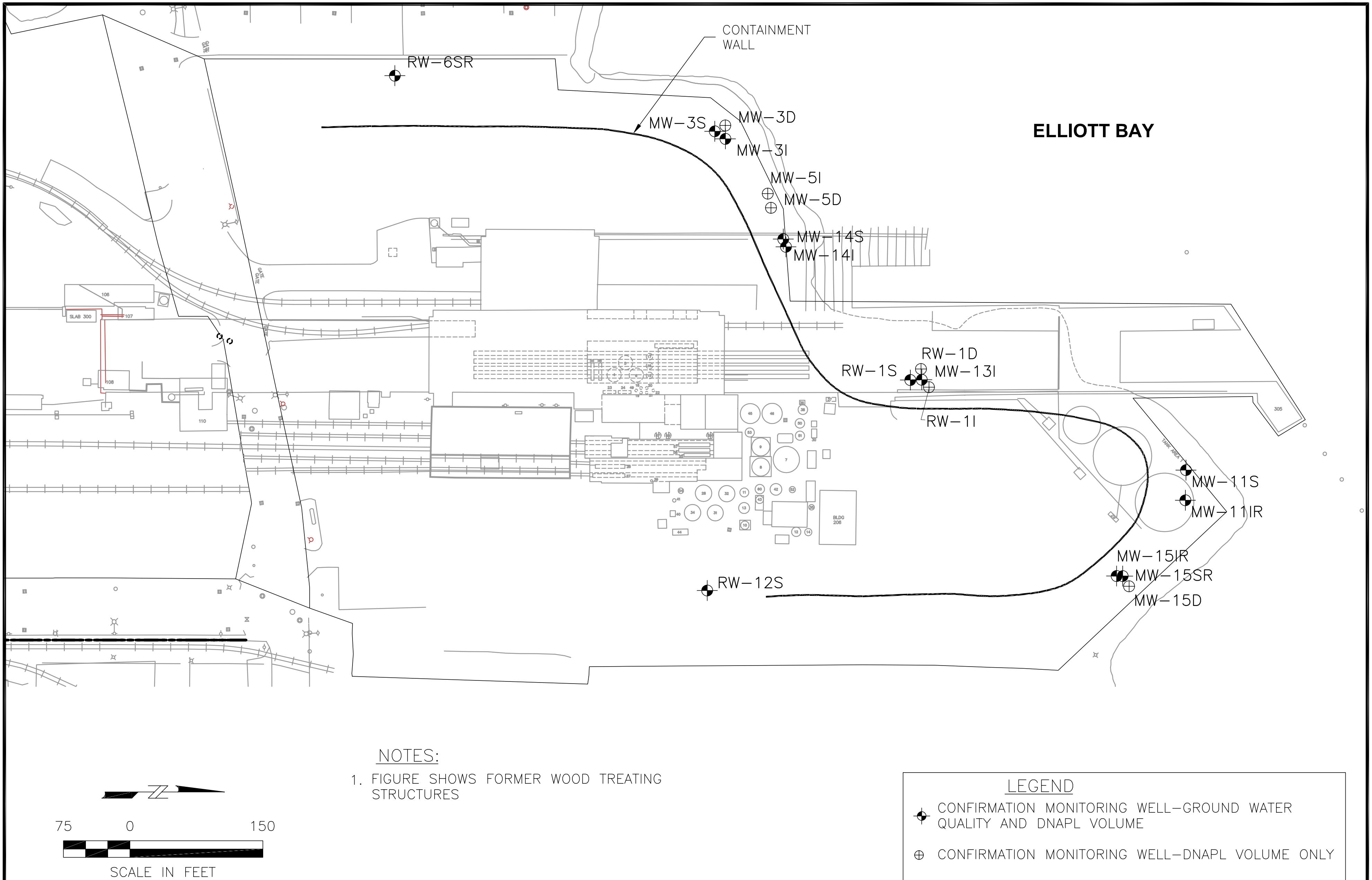
PORS1-18323-200

DATE: 08/16/04 DRWN: A.S./SEA

LOCATION OF CAP, CONTAINMENT WALL AND LNAPL TRENCH

PSR SUPERFUND SITE

FIGURE 4-1



NOTES:

1. FIGURE SHOWS FORMER WOOD TREATING STRUCTURES

LEGEND

CONFIRMATION MONITORING WELL−GROUND WATER QUALITY AND DNAPL VOLUME

CONFIRMATION MONITORING WELL−DNAPL VOLUME ONLY

RETEC

PORT OF SEATTLE

PORS1-18323-200

DATE: 08/16/04 | DRWN: A.S./SEA

CONFIRMATION MONITORING WELL NETWORK

PSR SUPERFUND SITE

FIGURE 4-2

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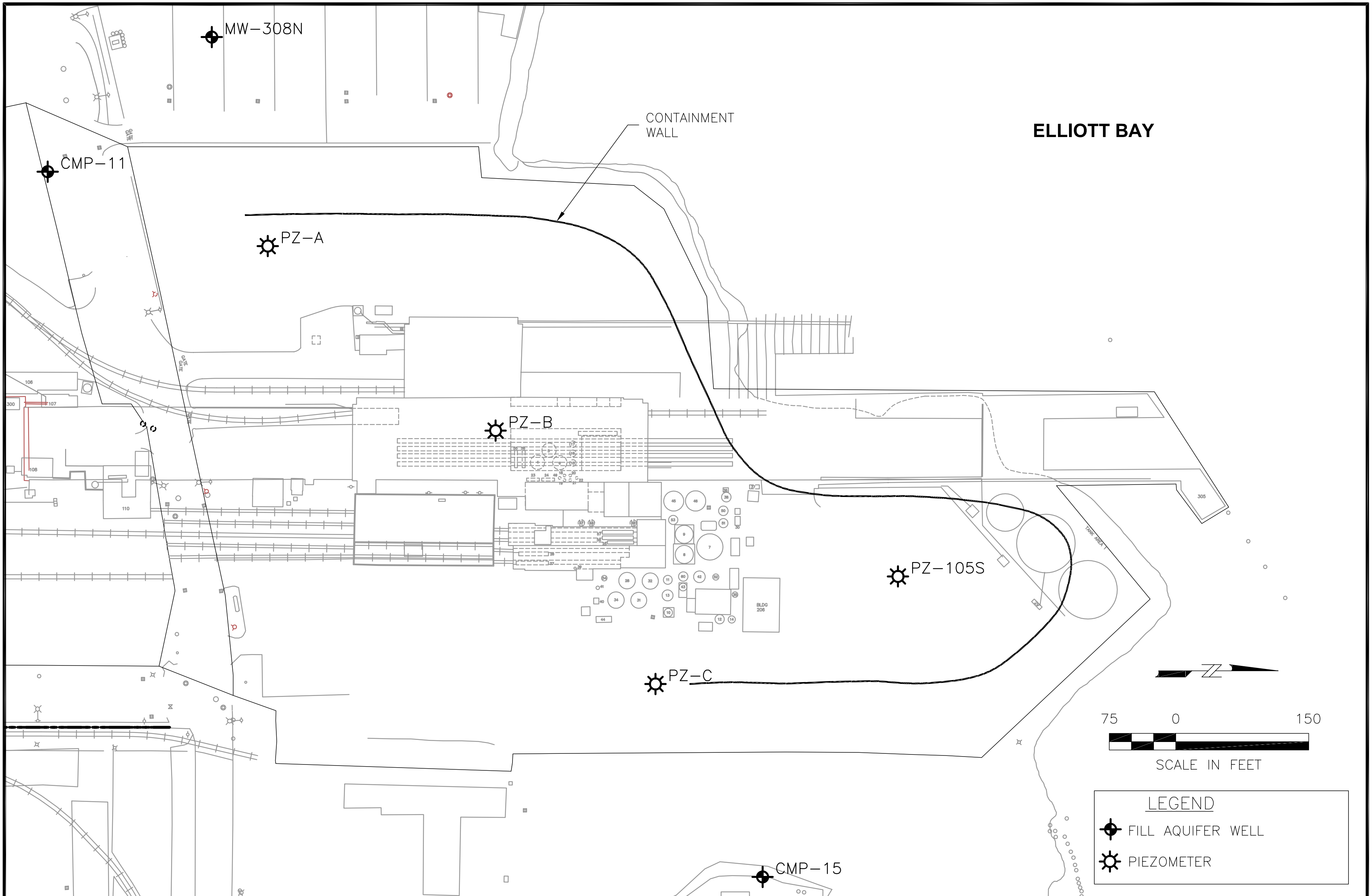


RETEC

PORT OF SEATTLE

PORS1-18323-200

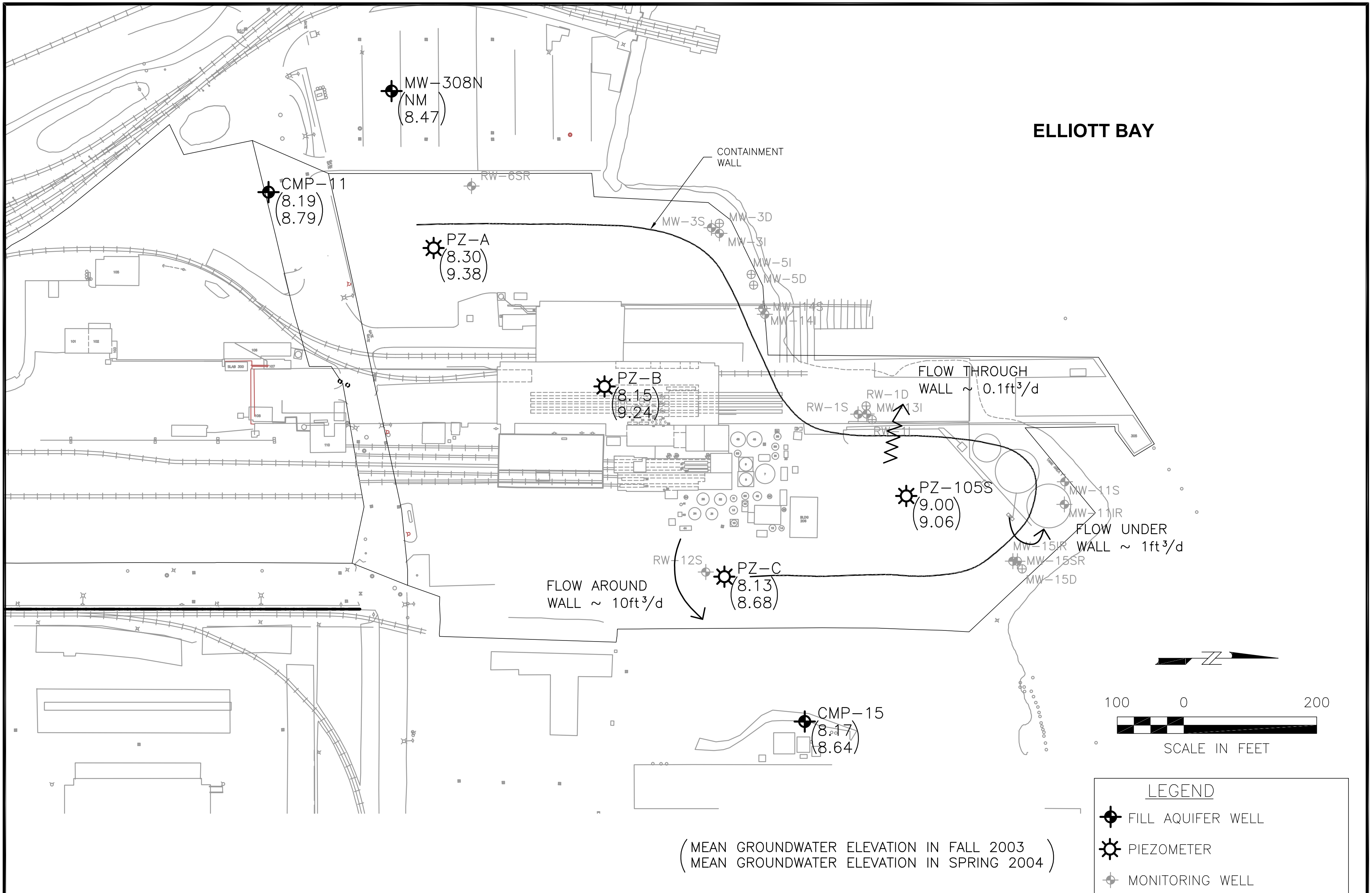
DATE: 08/16/04 | DRWN: A.S./SEA

TIDAL STUDY
WELL/PIEZOMETER LOCATIONS

PSR SUPERFUND SITE

FIGURE 4-3

File: H:\18323\18323S006.dwg Layout: Layout1 User: astenberg Plotted: Sep 08, 2004 - 10:38am Xref's:



RETEC

PORT OF SEATTLE

PORT4-18323-200

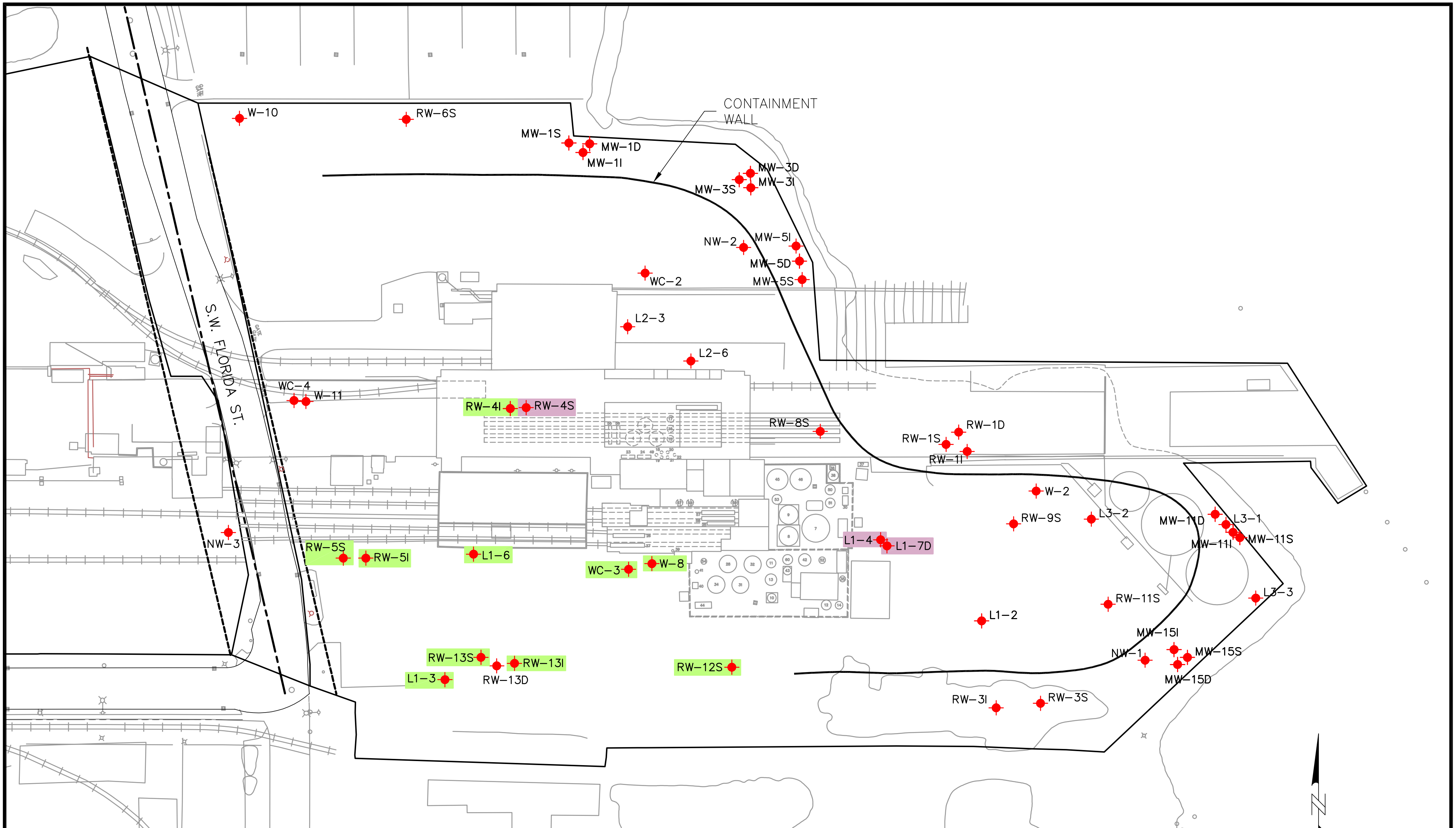
DATE: 09/03/04 DRWN: A.S./SEA

GROUNDWATER FLOW

PSR SUPERFUND SITE

FIGURE 7-1

File: H:\18323\18323S007.dwg Layout: ANSI_AI-CP User: astenberg Plotted: Sep 07, 2004 - 11:32am Xref's:



LEGEND

SAMPLED MONITORING WELL

KEY

GROUNDWATER CONCENTRATIONS REVIEWED AS PART OF FLOW ASSESSMENT

GROUNDWATER NOT SAMPLED DUE TO PRESENCE OF PRODUCT

75 0 150

SCALE IN FEET

RETEC

PORT OF SEATTLE

PORT4-18323-200

DATE: 09/07/04 DRWN: A.S./SEA

MONITORING WELLS SAMPLED DURING RI/FS

FIGURE 7-2

Appendix A

Estimation of Groundwater Flow from the Nearshore Barrier Wall

Memorandum

Date: September 1, 2004

From: Michael Riley

To: Linda Baker

Project: SSP-728

Subject: **PSR Site**
Estimation of Groundwater Flow from the Nearshore Barrier Wall

Introduction

Groundwater flow in the vicinity of the PSR nearshore barrier wall has been monitored through two tidal studies conducted in the Fall of 2003 and the Spring of 2004. Mean water levels developed from the tidal studies are shown on Figure 1. This memorandum addresses the potential for flow from within the barrier wall based on these studies.

Flow Paths

Groundwater levels shown on Figure 1 indicate three components of flow from within the barrier wall: flow through the wall, flow under the wall, and flow around the wall. The flow through the wall and under the wall is essentially the same for each tidal study since the mean water level at PZ-105s and mean water level in Elliott Bay do not change significantly between studies.

The component of flow at the upland end of the wall varies with time and varies between the eastern and western ends of the wall. In both tidal studies water levels at the western end of the wall were higher than at the eastern end of the wall (PZ-A and PZ-C). Water levels at the western end of the wall were also higher than water levels outside of the wall to the south and west (PZ-A, CMP-11, and MW308N). Water levels on the east end of the wall were lower than within the wall (PZ-C and PZ105s), but varied from slightly higher to slightly lower than water levels outside the wall (PZ-C and CMP-15).

Based on the horizontal gradients observed from the tidal studies, there is a weak and variable flow around the ends of the wall. The gradient is stronger at the west end of the wall, but gradients at this location indicate both westerly and northeasterly flow. The northeasterly component of flow at this location prevents contaminant migration from the PSR process area to the west end of the wall.

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www.sspa.com • e-mail: mriley@sspa.com

The gradient from PZ-105s to PZ-C indicates that there is a component of flow from inside the wall to the east end of the wall. However, the gradient around the end of the wall to the east is very weak as evident from the nearly identical water levels observed at PZ-C and CMP-15. This indicates that the component of flow from within the wall is small compared to the ambient groundwater flow.

Estimation of Groundwater Flow along Flow Paths

The groundwater flow rates along the different pathways were analyzed to provide a comparison between pathways. The total recharge from infiltration within the area bounded by the barrier wall was then allocated among the different pathways.

Recharge primarily occurs along railroad tracks in the area covered with an asphalt cap as there is a small open area between the asphalt and the tracks. Based on inspection of the area, the openings adjacent to the cap cover approximately 1.3 percent of the total cap area within the barrier wall. Asphalt adjacent to the tracks is graded to convey runoff away from the openings between the cap and tracks. Assuming 100 percent infiltration of direct precipitation on the gap between the cap and tracks results in approximately 0.45 inches of recharge per year.

Groundwater flow around the east end of the cap is primarily from the area near PZ-105s and includes the former tank farm areas north of the former retort area and the former tank farm near the shoreline. This encompasses an area of approximately 80,000 ft^2. Based on the areal recharge estimate, the total recharge to this area is approximately 3000 cubic feet per year or approximately 0.04 gpm.

This total flow is then allocated among three pathways around, under or through the wall based on the gradient and hydraulic parameters along each pathway. The basic equation for each pathway is Darcy's equation given by:

$$Q = A \times K \times dh/dl$$

Where:
Q is the Darcy's flux in volume per time
A is the flux area
K is the hydraulic conductivity of the flow path
dh/d*l* is the hydraulic gradient along the flow path
h is the head difference across the flow path
l is the length of the flow path

Underflow Pathway. The barrier wall extends to the estuarine unit, which provides a resistance to vertical movement under the wall. The estuarine unit is typically thicker than 10 feet. Conservatively assuming that the water level in groundwater below the estuarine unit is approximately the same as the water level in the bay, the gradient across the estuarine unit is computed as the head difference between PZ-105s and the bay divided by the thickness of the estuarine unit. This gives a hydraulic gradient of 0.26 to 0.27. Vertical hydraulic conductivity of the estuarine unit is taken from permeability tests conducted on estuarine soil and is estimated at 3.4e-8 ft/s (0.0029 ft/d). The flow area is the same as the recharge area or 80,000 ft^2.

Pathway through the Wall. Groundwater flow through the wall is estimated from the gradient from inside to outside the wall, the thickness and permeability of the wall, and the area of the wall below the water table. The thickness of the wall is estimated at 3 feet and the permeability is estimated as 2.6e-7 cm/s (7.3e-4 ft/d) based on design specifications. The wall area is estimated as that portion of the wall around PZ-105s with a saturated depth of 10 feet above the estuarine unit. The head difference for computing the gradient is taken as the difference between the water level in PZ-105 and the water level in the bay.

Pathway around the Wall. The gradient for this pathway is computed from PZ-105s and PZ-C. While the other pathways are uniform with time, this pathway varies seasonally. The gradient from the Fall tidal study is 0.0034 and from the Spring tidal study is 0.0013. The saturated thickness above the estuarine unit is estimated as 10 feet and the width of flow is taken as 200 feet, which is the distance between the wall at PZ-105s. Hydraulic conductivity is taken as the geometric mean of data from slug tests on site for a value of 8e-4 ft/s (69 ft/d).

The relative proportions of flow along each pathway and the corresponding total flow based on available recharge is provided in the following table.

Pathway	Darcy Flux	Proportion of Flow (%)	Discharge (ft^3/d)
Underflow	63	16	1.3
Wall Flow	5.9	1.5	0.1
Flow around Wall	328	83	9.6

Results

The primary groundwater pathways from the area of the barrier wall are vertically downward and horizontally around the east end of the wall. The total flow is however very small due to the asphalt cap extending over most of the site. The smallest component of flow is direct flow through the wall, which is less than 2 percent of the water infiltrating through the asphalt cap.