Final Cleanup Action Plan

PSC Georgetown Facility

Seattle, Washington

Prepared for:

Burlington Environmental, LLC
(a wholly owned subsidiary of PSC Environmental Services, LLC)
18000 72nd Avenue South, Suite 217
Kent, Washington 98032

Prepared by:

Washington State Department of Ecology

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ACRONYMS AND ABBREVIATIONS

API	Asian and Pacific Islander
ARARs	applicable or relevant and appropriate requirements
AWQC	ambient water quality criteria
BTEX	benzene, toluene, ethylbenzene, and xylenes
bgs	below ground surface
CAP	Cleanup Action Plan
CAP Area	area addressed by this Cleanup Action Plan
CAS	Columbia Analytical Systems, Inc.
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
cm/sec	centimeters per second
CPOC	conditional point of compliance
COC	contaminant (or "constituent") of concern
CPS	construction plans and specifications
CSM	conceptual site model
CULs	cleanup levels
DNAPL	dense nonaqueous phase liquid
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EDR	engineering design report
EI	Environmental International
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPH	extractable petroleum hydrocarbons
FS	feasibility study
ft	feet
ft/year	feet per year
GAC	granular activated compound
gpm	gallons per minute
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCIM	hydraulic control interim measure
HCIM Area	area within/behind the hydraulic control interim measure barrier wall
HDPE	high-density polyethylene

ACRONYMS AND ABBREVIATIONS
(Continued)

IM	interim measure (sometimes also called "interim action")
IPIM	inhalation pathway interim measure
ISB	in situ bioremediation
ISCO	in situ chemical oxidation
KCDNRP	King County Department of Natural Resources and Parks
$KMNO_4$	potassium permanganate
lb	pounds
lb/day	pounds per day
mg/kg	milligrams per kilogram
µg/l	micrograms per liter
MCL	Maximum Contaminant Levels (Clean Water Act)
MDL	method detection limit
MNA	monitored natural attenuation
MTCA	state of Washington Model Toxics Control Act
NA	natural attenuation
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O_3/Ox	ozone oxidation
O&M	operation and maintenance
OSRA	Outside Soil Remediation Area
Outside Area	the area outside the boundaries of the HCIM Area included in this CAP (this area includes portions of the site east of 4th Ave. S.)
PAH	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
Permit	PSC Georgetown Facility, RCRA hazardous/dangerous waste (Part B) Permit
PID	photoionization detector
PLC	programmable logic controller
PLP	potentially liable persons
POC	point of compliance
POTW	publicly owned treatment works
PPB	parts per billion
PQL	practical quantitation limits
PSC	Philip Services Corporation

ACRONYMS AND ABBREVIATIONS
(Continued)

PSCAA	Puget Sound Clean Air Agency
PVC	polyvinyl chloride
RAO	remedial action objective
RCRA	federal Resource Conservation and Recovery Act
RCW	Revised Code of Washington
redox	reduction/oxidation
RI	remedial investigation
RI Report	Final Comprehensive Remedial Investigation Report for PSC Georgetown Facility and subsequent addenda
RL	remediation level
SAD	Stone-Drew/Ashe & Jones
site	PSC's Georgetown RCRA facility and other areas affected by releases that occurred at the facility. The PSC site is a larger area than the area addressed in this CAP.
SPOC	standard point of compliance
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWFS	Site Wide Feasibility Study
SWFS Area	areas within the scope of the SWFS. This is the area the CAP focuses on, which is limited to contamination east of 4th Ave. S.
TASCO	the Amalgamated Sugar Company
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TM-5	Technical Memorandum (or "tech memo") No. 5
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal of hazardous waste
U.S.C.	United States Code
USGS	U.S. Geological Survey
UPRR	Union Pacific Railroad
UST	underground storage tank
UV/Ox	hydrogen peroxide and ultraviolet light
VIAM	vapor intrusion assessment and mitigation
VOCs	volatile organic compounds
WAC	Washington Administrative Code

FINAL CLEANUP ACTION PLAN

PSC Georgetown Facility
Seattle, Washington

1.0 INTRODUCTION

As required by Washington Administrative Code (WAC) 173-340-380, the Washington State Department of Ecology (Ecology) is issuing this final Cleanup Action Plan (CAP) for a cleanup action to be conducted by the Burlington Environmental, LLC, a wholly owned subsidiary of PSC Environmental Services, LLC (hereafter referred to as PSC) under an agreed order.

1.1 TERMINOLOGY AND SCOPE

The PSC Georgetown site is located in Seattle, Washington (Figures 1 and 2). Because the response to the contamination associated with PSC's property and site is regulated under both federal and state statutes, some terms – such as *site* and *facility* – can have multiple and somewhat different meanings. This section attempts to explain these differences and describe the terminology that will be used in the CAP.

Throughout the CAP, the term "RCRA facility" will be used to refer to the former Resource Conservation and Recovery Act (RCRA) hazardous/dangerous waste operations located at 734 South Lucile Street, a property now owned by PSC. These waste operations ceased in December 2002, and the active RCRA facility was closed in August of 2003. The term "RCRA corrective action facility," as used below, includes property adjacent to the RCRA facility property that was acquired by PSC following closure of its dangerous waste operations. This additional property (at 5400 Denver Ave. S.), located northwest of 734 S. Lucile St., was formerly owned by the Amalgamated Sugar Company (TASCO). It has been impacted by historical releases of hazardous substances from PSC's RCRA facility.

The RCRA facility's hazardous/dangerous waste permit, issued by the US Environmental Protection Agency (EPA) and Ecology in 1991, requires PSC to perform corrective action (cleanup) within and beyond the boundaries of the permitted RCRA facility to address releases of hazardous substances. The Washington State Model Toxics Control Act (MTCA) regulations, WAC Chapter 173-340, also require PSC to perform cleanup actions to address releases "where a hazardous substance has been deposited, stored, disposed of, placed, or otherwise come to be located". This area of contamination is called the MTCA "site" or "facility," the terms are essentially synonymous. Since both MTCA (WAC 173-340) and the Dangerous Waste (WAC 173-303) regulations use the term "facility," and use it for different purposes, this can be confusing at sites where both authorities have jurisdiction. In this CAP we have therefore only used the term "facility" in its hazardous waste context. We consistently use "site" to refer to the MTCA area of contamination that includes both the PSC RCRA facility and other areas that have been affected by releases that occurred at, or through operation of, the RCRA facility (please see Figure 3 for a depiction of the site area). Although we will not use the term "facility" in this document as MTCA defines it, but instead will use it to only refer to PSC's RCRA facility, located on PSC-owned property, readers should understand that we have in no way limited the boundaries of what MTCA would consider PSC's Georgetown *facility* (i.e. the site).

This CAP is therefore intended to meet:

- corrective action-related requirements in the PSC Georgetown RCRA facility permit, and
- the requirements of Washington State's MTCA cleanup regulations.

The Department of Ecology is the lead agency for overseeing compliance with these requirements.

Groundwater contamination associated with the PSC site is currently located in areas east and west of 4th Ave. S. Contamination west of 4th Ave. S. is due in part to migration of contaminated groundwater westward, the general flow direction for groundwater movement in the site area. Between 2001 and 2004 PSC investigated groundwater contamination west of 4th Ave. S., installed monitoring wells in that area, and took actions to protect indoor air quality from volatilizing groundwater contamination. However, it soon became clear that some of the contamination detected in the area had more local sources. As a consequence, in 2006 Ecology agreed to the following steps:

(1) we would determine which properties in the west-of-4th Ave. area downgradient of PSC's property might be sources of local groundwater contamination;
(2) we would ask the owners of these other properties to investigate the nature and extent of contamination caused by releases at their properties; and,

> (3) we would not require that PSC perform a feasibility study, or prepare a cleanup action plan, for contamination west of 4th Ave. S. until the owners of these other properties have completed an adequate degree of investigation.

PSC, therefore, proceeded to conduct a feasibility study (FS) for only the contamination present **east of 4th Ave. S**. Following the completion of that study this CAP was prepared. The CAP, like the FS then, only focuses on contamination east of 4th Ave. S. (as shown in Figure 4). PSC's obligations for addressing contamination west of 4th Ave. S. will be resumed once the remedial investigations associated with the west-of-4th properties referred to above have been satisfactorily completed.[1] At that time it is expected that an area-wide, west-of-4th FS will be undertaken by PSC and some or all of the potentially liable persons (PLPs) now performing remedial investigations.

The area of contamination PSC is proposing to address in this CAP is limited to contamination currently present east of 4th Ave. S. Unfortunately, however, the terminology chosen for this area in the past was *site wide*. PSC's FS documents, therefore, refer to a "site wide" study, even though the contamination being evaluated for cleanup is limited to contaminated areas east of 4th Ave. We realize this can be confusing. So in the CAP, unless we are referring to a specific document that includes the term, we do not use "site wide" to refer to the area of contamination we are focusing on. Instead, we simply call the area *the site east of 4th.* Readers should understand, though, that we are referring to the same east-of-4th area that PSC and Ecology have called the "site wide" area in FS reports, technical memoranda, and letters over the past two and a half years.

1.2 PURPOSE OF THE CLEANUP ACTION PLAN

The purpose of the CAP is to summarize the results of PSC's remedial investigation/feasibility study (RI/FS) work, including a summary and rationale for selection of the proposed cleanup actions. A draft CAP presents to the public the proposed cleanup action, proposed cleanup standards that are expected to be achieved, and the proposed approach and schedule for implementing the cleanup. During the comment period the public is provided an opportunity to review the draft CAP and submit comments to Ecology. Once the comment period closes

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[1] At this time three companies are separately performing remedial investigations under MTCA orders. The companies are: Art Brass Plating at 5516 3rd Ave. S., Blaser Die Casting at 5700 3rd Ave. S., and Capital Industries at 5801 3rd Ave. S. In each case the primary contaminants of concern at the sites are chlorinated solvents.

Ecology considers all comments received before finalizing the CAP. In addressing the comments Ecology may need to propose a revised draft CAP to the public before finalizing the document. This would entail a second comment period.

1.3 PROPOSED ACTION SUMMARY

The site area addressed by the CAP has been divided into two mutually-exclusive cleanup action areas: (1) the area enclosed by the Hydraulic Control Interim Measure barrier wall (the "HCIM Area"), and (2) the portion of the CAP Area outside the barrier wall (the "Outside Area"). The two areas are shown on Figure 4. So, to keep these subdivisions straight, the reader should remember that:

- the PSC site extends from the southwest part of Union Pacific's Argo Yard, east of PSC's property, to the Duwamish Waterway;
- the part of the PSC site located west of 4th Ave. S. is not being addressed in this CAP; and,
- the part of PSC's site east of 4th Ave. S. is addressed in the CAP, and within this area there are two sub-areas. There is an HCIM Area (inside the barrier wall), and there is an Outside Area (outside the barrier wall).

The HCIM Area includes the property encircled by the barrier wall (and the wall itself) that PSC either owns or has secured a subsurface easement to. The Outside Area is located outside the barrier wall and includes:

- a small area of the PSC RCRA facility, south of the wall;
- areas within adjacent properties (such as a portion of the Union Pacific Railroad [UPRR] Argo Yard); and,
- areas of contaminated groundwater downgradient of the HCIM barrier wall to 4th Ave. S.

Outside Area properties have multiple owners, both public and private.

The remediation technologies and institutional controls appropriate for the HCIM Area are substantially different from those appropriate for the Outside Area. As such, separate remedial alternatives were evaluated for these two areas in PSC's FS. The proposed cleanup action in this CAP combines the preferred alternatives for the two sub-areas to develop a comprehensive remedial approach addressing the entire CAP area.

The combination of actions proposed in the cleanup proposal summarized below has been developed to constitute the most permanent, practicable cleanup action for the eastern portion (east of 4th Ave.) of PSC's site. It must meet the threshold requirements of PSC's permit and WAC 173-340-360 to:

- protect human health and the environment,
- comply with cleanup standards,
- comply with applicable state and federal laws, and
- provide for compliance monitoring.

The principal features of the proposed cleanup action are shown in Figure 5 for each area and discussed in more detail in Section 6. The action includes the elements described in subsections 1.3.1 and 1.3.2 below, several of which have already been implemented as interim actions.

1.3.1 HCIM Area

- A totally enclosing, low-permeability subsurface barrier wall which surrounds most of the RCRA facility and isolates contaminated groundwater within the enclosed area (**implemented** as part of the HCIM interim action in 2003/2004);

- A groundwater recovery and treatment system to maintain an inward hydraulic gradient within the barrier wall area (**implemented** as part of the 2004 HCIM). This system maintains pressures across the wall such that any leakage through the wall should result in groundwater coming inside the enclosed area (from the Outside Area), not leaving it;

- Excavation and off-site disposal of approximately 200 cubic yards of soil on the former TASCO property that contained concentrations of polychlorinated biphenyls (PCBs) above 10 mg/kg;

- Water table-lowering (partial dewatering) and soil vapor extraction (SVE) within the enclosed area. SVE will remove and treat volatile contaminants from soils above the water table. It was implemented in PSC's north field area as an interim action in 1994. This second phase of SVE, included in the CAP, will focus on HCIM areas not previously addressed;

- In situ bioremediation (ISB) via electron donor injection into contaminated groundwater behind the barrier wall. ISB will reduce the mass of certain types of organic contaminants (chlorinated ethenes, for example) in groundwater;

- A low-permeability surface cover[2] that would completely cover the area enclosed by the HCIM barrier wall (this covering is mostly in place now). Cover will prevent exposures to soil contamination and reduce the amount of precipitation entering groundwater behind the wall;

- A long-term natural reduction of some COC mass in soils and groundwater within the enclosed area;[3]

- A monitoring program utilizing existing and new wells to monitor groundwater quality behind the wall. The program will measure the performance of the actions taken and contaminant concentrations over the long-term;

- A monitoring program to measure groundwater levels in monitoring wells inside and outside the barrier wall. The program will confirm that hydraulic containment is maintained (this component was **implemented** as part of the 2004 HCIM);

- Institutional controls. These controls will restrict groundwater use within the enclosed area, restrict and regulate subsurface work conducted within the enclosed area, require vapor intrusion mitigation as part of any building construction within the HCIM Area, require continued operation of the HCIM system, and require maintenance/repair of the barrier wall, surface cover, and monitoring well system; and,

- Financial assurance to implement the cleanup action, monitor its performance, and provide for long-term operation, maintenance, and repair of the HCIM system (including the cap). PSC's permit requires financial assurance to cover corrective action costs associated with the HCIM Area, the Outside Area, and the site area west of 4th Ave. S. (i.e., the entire site).[4]

1.3.2 Outside Area

- The existing Inhalation Pathway Interim Measure (IPIM) Vapor Intrusion Assessment and Mitigation program that protects indoor air quality within the Outside Area (**implemented** in 2003). This program would be maintained as long as subsurface contamination in the Outside Area poses an unacceptable vapor intrusion threat;

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[2] With the goal to effectively "cap" uncovered areas. So the cover could, in places, be paving, and in other places, buildings.

[3] Many of the organic contaminants present in the area preferentially biodegrade in the absence of oxygen (anaerobic degradation). Groundwater geochemical conditions behind the barrier wall are presently suitable for this type of "natural" remediation.

[4] The new PSC permit incorporates by reference an Agreed Order which contains financial assurance requirements. These requirements are fully enforceable under the permit.

- SVE to remediate subsurface soils located: a) between the HCIM barrier wall and the Stone-Drew/Ashe & Jones (SAD) property, and b) on the UPRR Argo Yard property (please see Figure 5). SVE will reduce levels of volatile organic compounds (VOCs) in contaminated soils;

- Excavation and off-site disposal of contaminated soils in the UPRR Argo Yard property east of PSC's RCRA facility. The soils to be excavated include those that are contaminated with PCBs and other hazardous substances (please see Figures 5 and 5A);

- Placement of additional surface cover over contaminated soil areas located on PSC and UPRR Argo Yard properties in the Outside Area (please see Figures 5 and 5A). Cover will primarily prevent exposures to soil contamination left following the actions described above;

- Enhanced bioremediation by a one-time placement of electron donor material into the base of select excavations prior to placement of backfill to treat groundwater on the UPRR Argo Yard property in the areas of soil excavation;

- A comprehensive Outside Area monitoring well network and monitoring program. The program will assess groundwater quality: a) at the conditional point of compliance (CPOC);[5] b) in Argo Yard; and, c) in areas downgradient from the CPOC. The monitoring program will track the **natural attenuation** of groundwater contamination over time and thereby provide a means of measuring the performance of the final remedy. It will be used to determine if the implemented cleanup action is effective, or needs to be changed (e.g., supplemented with one of the contingent remedies);

- Outside Area "controls." A combination of administrative controls, institutional controls, and public communications will be implemented to restrict groundwater recovery within the Outside Area, limit the potential for exposure to contaminated soils,[6] and notify the public of potential risks and hazards associated with subsurface work in contaminated areas;

- Investigation of potential 1,4-dioxane sources in areas near, but downgradient of, the RCRA facility. The investigation will attempt to determine if groundwater contaminated with 1,4-dioxane may be a result of releases from properties in addition to PSC's facility; and,

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[5] As explained further in Section 4.1, the CAP establishes a conditional groundwater point of compliance for the eastern part of PSC's site immediately downgradient of the subsurface barrier wall. This requires that PSC attain applicable cleanup levels at this "point" and all points downgradient.

[6] Soils in the Outside Area have not, for the most part, been contaminated by releases from PSC's RCRA facility. The exception to this is soils on properties immediately adjacent to the RCRA facility, but outside the barrier wall, such as Argo Yard.

- financial assurance to implement the cleanup action and monitor its performance.

In addition to the above, PSC is proposing to establish financial assurance for implementing two contingent remedies for the Outside Area.

1. Current data show that 1,4-dioxane exceeds applicable groundwater cleanup levels in places within the Outside Area. A *hotspot* of 1,4-dioxane is located near monitoring well CG-122-60 (Figure 5), at the intersection of Lucile St. and Maynard Ave. Monitoring data indicate that the concentrations of 1,4-dioxane within the Outside Area are being naturally reduced (attenuated), and dioxane cleanup levels throughout the Outside Area may be reached within a reasonable timeframe solely by the actions of dilution and dispersion.[7]

   Ecology will decide by 2010 whether natural attenuation is achieving cleanup of 1,4-dioxane within the Outside Area within a reasonable timeframe. It is possible that by this time additional sources of the dioxane contamination will also be discovered.[8] If in 2010 natural attenuation does not appear capable of achieving cleanup within a reasonable timeframe,[9] PSC will implement a mass-reduction action. The contingent remedy, pending the results of the evaluation referred to above and continued monitoring, is proposed to be groundwater extraction at/near well CG-122-60 and aboveground treatment via advanced oxidation.

2. A number of organic and inorganic substances presently exceed groundwater cleanup levels at and downgradient of the Outside Area CPOC. Although there is good reason to believe that the combination of proposed actions being taken at the site, including natural attenuation, will achieve cleanup levels within a reasonable timeframe, it is possible that one or more substances may attenuate more slowly than expected. For example, current data show that vinyl chloride greatly exceeds applicable groundwater cleanup levels at monitoring well CG-104-I, located just west of the barrier wall (east side of Denver Ave.). If it appears that some substances are not attenuating to the degree anticipated, and cleanup levels are unlikely to be attained within a reasonable timeframe, PSC will need to implement additional actions. This CAP proposes a contingent remedy of air sparging (or a similar technology) along the western PSC property boundary and/or on the UPRR Argo Yard property. The contingent remedy is based on an assumption that the most likely scenario -- in the event of failure to attain all cleanup levels within a reasonable timeframe -- is persistently elevated vinyl chloride and/or metals in downgradient groundwater near the barrier wall. PSC will establish financial

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[7] 1,4-dioxane is a chemical not expected to significantly biodegrade in the environment.

[8] PSC intends to conduct an investigation into the possibility that other sources of the compound are present in the Outside Area.

[9] 2010 will be the first evaluation of natural attenuation's performance. If the attenuation rate appears to be satisfactory in 2010, Ecology will re-visit performance at intervals in the future to ensure that the rate is maintained and cleanup levels achieved.

assurance to implement the contingent remedy, and it could be implemented at any time once it has been determined that additional actions are needed to attain cleanup levels within a reasonable timeframe.

1.4 CAP ROADMAP

The CAP continues in Section 2 with a description of the PSC site and historical information concerning use of the PSC RCRA facility property. This is followed by a condensed history of corrective action (the investigation and cleanup process) at the site.

Section 3 is devoted to summarizing the site Remedial Investigation. This section briefly describes the contamination associated with the site and discusses the site “conceptual model,” a framework for looking at the contamination and how it might affect various “receptors.”

Section 4 discusses cleanup levels and points of compliance. It also describes “remediation levels” that are used to identify concentrations of contaminants that are sufficiently low to protect a particular exposure pathway (or multiple pathways), though above concentrations that must be achieved by the final cleanup (cleanup standards).[10]

Section 5 summarizes PSC’s FS by presenting the cleanup options that were evaluated to address the contamination in the eastern part of the site.

Section 6 further describes the cleanup action that Ecology has selected for the eastern part of PSC’s site (east of 4th Ave. S.). This is the action outlined in 1.2 and 1.3 above. Section 6 also discusses requirements for institutional controls and financial assurance that must accompany the proposed action.

Section 7 briefly explains how and when the proposed cleanup action will be implemented.

In many sections references will be made to appendices that contain more detailed information. For example, Section 5 simply summarizes each of the eleven cleanup alternatives evaluated in depth by PSC. Appendix C and Appendix E include additional information about each of those alternatives.

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[10] Remediation levels are defined in WAC 173-340-200 and discussed more fully in WAC 173-340-355.

2.0 SITE DESCRIPTION AND BACKGROUND

This section briefly:

- describes the RCRA facility, surrounding property, and eastern portion of the PSC site;
- discusses the land use associated with the eastern portion of the site; and,
- summarizes the RCRA facility's regulatory and corrective action background.

2.1 SITE DESCRIPTION

2.1.1 Physical Description

The RCRA facility is located at 734 South Lucile Street, Seattle, King County, Washington, in the Georgetown neighborhood of south Seattle. As shown on Figure 2, the RCRA facility is bordered on the east and north by the UPRR Argo Yard property. South Lucile Street borders the RCRA facility on the south, and Western Trailer Repair, Inc., is located across from PSC's property on the north side of South Lucile St. Immediately to the west of the southern part of the RCRA facility is Stone-Drew/Ashe & Jones, Inc., a plumbing supply warehouse at 710 S. Lucile St., owned by SAD Properties, LLC (SAD). PSC now owns adjacent property west of the northern portion of their facility (at 5400 Denver Ave. S.) formerly owned by TASCO. Mixed residential, industrial, and commercial properties are present in the areas surrounding the facility. The Duwamish Waterway is located approximately 0.75 miles west (downgradient) of the facility.

2.1.2 Land Use

The HCIM Area – which includes most of the RCRA facility and the TASCO property – has been used industrially since about 1936. It is expected to continue to be used primarily for industrial or commercial use in the foreseeable future. Properties that comprise the HCIM Area are zoned General Industrial 1 (IG1), which allows the heaviest degree of industrial use, and typically relies on rail and marine transportation.

The Outside Area – that part of the eastern portion of the site that is outside the barrier wall – is densely developed and includes private residences interspersed with both commercial and industrial operations. Many active subsurface utilities are also present in this area. Properties adjacent to the facility are zoned General Industrial 1 (IG1), and this zoning is consistent with historical ownership and use. The area west of Denver Avenue South and extending to Fourth Avenue South is zoned General Industrial 2 (IG2), which allows industrial as well as commercial uses (for those latter uses that do not interfere with industrial use). To the east of the RCRA facility is a rail yard (Argo Yard) owned and operated by UPRR with industrial use dating back to the early 1900s.

The Aronson property further north and west of PSC (at 5300 Denver Ave. S.) is a light industrial property used as a warehouse and service facility. The SAD property to the west and south is also a light industrial facility used for offices and warehousing. Both properties have been used for industrial/commercial purposes since about 1915.

The Georgetown neighborhood west of Denver Avenue South was predominantly residential until the 1970s, when industrial development of the area increased substantially. Today residences in the eastern portion of PSC's site are primarily found along Brandon and Lucile Streets, between Denver Ave. and 6th Ave. S., and along the north side of Lucile St. between 4th and 5th Avenues.

2.2 FACILITY HISTORY

A detailed site history is presented in the RI Report; here only a brief summary of the history for the eastern portion of the site is provided. Figure 6 shows prominent historical features at the PSC RCRA facility.

The 734 S. Lucile St. property was previously owned by Preservative Paint Company, Chemical Processors ("Chempro"), and Burlington Environmental, which later became a wholly owned subsidiary of PSC. The former west field of the RCRA facility, which was, prior to 1982, an unpaved area located near the boundary of the facility with the SAD property, was previously used for staining wood shakes and shingles and storing stains, solvents, and wastes. Two underground storage tanks (USTs) were located east of the west field, to the south and east of the former RCRA facility warehouse.

Twenty-four underground storage tanks (or "USTs") were installed between 1958 and 1965, and located within the former north field of the 734 S. Lucile St. property. The USTs were used by previous owners and operators to store materials such as thinners, solvents, and mineral spirits prior to 1970, and by Chempro and Burlington to store solvents, cyanide wastes, and other materials between 1970 and 1987. The USTs were removed from the facility in 1987.

Oils containing PCBs were also managed at the RCRA facility, and transformers containing PCB oils were temporarily stored on the western portion of the facility during the period from

1970 to 1989. Under a RCRA permit, jointly issued by US EPA and Ecology, hazardous waste treatment and storage operations occurred throughout the facility. As part of the operational permit, the facility was required to complete upgrades to facility process units and containment to prevent releases to the environment. Upgrades were completed by 1993, including a microsilica concrete cap over the entire facility, concrete berms around all containers, and a self-contained stormwater management system. Between 1993 and 2002, processes at the facility decreased. The distillation process was shut down in February 1996. Cyanide treatment was discontinued in March 2000. Oxidation treatment and fuel blending were the only processing operations occurring at the facility between March 2000 and December 2002. Operations ended completely in 2002, and the RCRA facility was formally "closed" in 2003.

PSC purchased the neighboring TASCO property in 2003 to construct the HCIM barrier wall (Figure 2). The TASCO property had been used as an industrial facility for sugar processing from the 1930s until 2003.

2.3 CORRECTIVE ACTION HISTORY

Corrective action at PSC's RCRA facility pre-dates PSC's ownership. In 1988 a RCRA §3008(h) Order was issued to Chemical Processors (the owner and operator at that time) requiring investigation of subsurface contamination at the facility. Later, in 1991, the order's investigation requirements were transferred into the facility's hazardous/dangerous waste permit. Investigation under the permit then continued for another twelve years. During this time PSC operated an SVE system in their north field and paved most of the RCRA facility at 734 S. Lucile with thick, high-density concrete. In 2001 a major modification of the permit established new corrective action requirements and an enforceable schedule.

Until 1998 investigation of contamination associated with PSC's facility focused primarily on the 734 S. Lucile St. property and the immediate area. In 1998 PSC sampled groundwater several blocks downgradient and confirmed that contamination had migrated to the west and southwest. In 2000 and 2001 this effort was expanded and groundwater in areas further west and southwest were sampled. PSC subsequently sampled downgradient groundwater all the way to the Duwamish River. Since groundwater contamination above applicable cleanup levels was found in a number of places throughout this area, in 2002 PSC installed some two dozen monitoring wells between the RCRA facility and the Duwamish River.

To begin addressing the detected contamination and to better protect "receptors" (people and parts of the environment potentially exposed to the contamination), PSC implemented several interim actions. Additional information about these actions is contained below and in Appendix A.

Barrier Wall

During 2003 and 2004, PSC implemented a hydraulic control interim measure (HCIM). The HCIM required construction of a subsurface barrier wall underlying much of the RCRA corrective action facility. Implementation of an effective HCIM required that PSC purchase the TASCO property and adjoining railroad spur, and acquire easements on two other properties adjacent to the facility (the Stone-Drew/Ashe & Jones property and the Aronson property) (Figure 2). The barrier wall was constructed using a *vibrating beam* technology that jetted panels of a material called *Impermix* into the subsurface. This non-permeable material stops the further movement of groundwater and groundwater contamination. PSC encircled much of the RCRA corrective action facility with the Impermix wall, thereby isolating heavily-contaminated groundwater and forcing groundwater east of their RCRA facility to flow around the property.

Vapor Intrusion Mitigation

Starting in 2002, PSC also carried out interim measures designed to protect indoor air quality in parts of the site where shallow groundwater was contaminated with volatile substances like trichloroethene. These types of substances can volatilize and migrate upwards in the soils above the water table. Once they encounter a building they can sometimes move indoors through cracks or other openings, contaminating indoor air. This *vapor intrusion* phenomenon was mitigated by PSC through the construction of thirty fan and piping systems in houses and other buildings across the site. The systems, similar to those used for keeping out radon gas, depressurize the area under the building and thereby minimize any movement of soil gases indoors.

PSC completed characterization of their site in 2003, and presented the results to Ecology in a “Final Comprehensive Remedial Investigation (RI) Report” (PSC, 2003). To obtain Ecology’s approval of the RI PSC subsequently prepared and submitted four RI addenda (PSC, 2004a,b,c,d). Taken together, these documents are referred to as *the RI Report*. In February 2004, Ecology approved PSC’s RI Report. Detailed information about the site remedial investigation is contained in Section 3 below.

Beginning in 2000 PSC and the regulatory agencies took a number of actions to improve communication with the local Georgetown community. This led to the establishment of a local document repository, quarterly newsletter mailings, and the scheduling of site-related public meetings and "open houses" at key junctures during the RI. A state grant was also provided to the Georgetown Community Council, which funded an environmental consultant who could review site documents and decisions independent of PSC, EPA, and Ecology. Although the 2003 RI Report was available for review at the local repository and was reviewed by the Community Council's consultant, however, no *formal* public comment period was established for it. The public was therefore encouraged to review the RI Report as part of the draft CAP review process.

Following completion of the RI PSC began a study of possible cleanup options for the eastern portion of the site. This culminated in a draft "Site Wide" Feasibility Study Report, submitted to Ecology in September of 2005 (Geomatrix, 2005). In response to comments received from Ecology, PSC and Ecology agreed to use a collaborative, phased approach to revising the Report. The phased process sought to achieve consensus on fundamental cleanup issues such as the point of compliance and cleanup standards before evaluating candidate cleanup options and selecting a preferred cleanup action. Five FS technical memoranda were therefore prepared (Geomatrix, 2005, 2006a,b,c, 2007a,b; Pioneer, 2006) and reviewed, the first being limited in scope to the establishment of cleanup levels and the last concerned with selecting a preferred remedy. The fifth technical memorandum was conditionally approved by Ecology on December 26, 2007 (Ecology, 2007).

Once the fifth FS technical memorandum was approved, the FS for the eastern portion of PSC's site was complete.[11] PSC did not prepare a Revised/Final FS Report since the five FS technical memoranda, once approved, satisfactorily revised the 2005 draft Report.

Similar to the RI, FS documents were available for review at the local repository and were reviewed by the Community Council's consultant, but no formal public comment period was established for the draft Report or subsequent technical memoranda. The public was therefore

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[11] The December 21, 2007, Ecology letter approving FS Tech Memo 5 noted that some elements of the FS were not completed . For example, the preferred remedy for the Union Pacific Railroad Argo Yard property had not been completely determined. These elements were addressed in 2008 and 2009 as part of the writing of this CAP.

encouraged to review the documents (and especially the five approved FS technical memoranda) as part of the draft CAP review process.

The corrective action history summarized above is abbreviated and primarily limited to post-2000 activities. The RI Report contains a much fuller description of the cleanup-related actions that were performed between 1988 and 2003.

3.0 REMEDIAL INVESTIGATION

The RI Report (PSC, 2003, 2004a-d) provides a comprehensive discussion of the nature and extent of contamination at the site. This section is a summary of that information.

3.1 HYDROGEOLOGY

The RI Report identifies five hydrogeologic units that occur with increasing depths within the cleanup area. These hydrogeologic units are described below in descending order:

- The *shallow sand unit* (including fill) is the uppermost hydrogeologic unit in the study area and consists of poorly graded, fine to medium sand with fine gravel and varies from 21 to 46 feet in thickness. The shallow sand unit grades into the intermediate sand and silt unit. PSC estimates a hydraulic conductivity of 3.2×10^{-2} (cm/sec) for the shallow sand unit based on grain size, slug test, and pumping test data.

- The *intermediate sand and silt unit* underlies the shallow sand and consists of discontinuous interbedded silty sand and sandy silt lenses with shell fragments. The unit ranges in thickness from 13 to 68 feet and is often indistinguishable from the overlying shallow sand unit. PSC estimates a hydraulic conductivity of 5.1×10^{-3} centimeters per second (cm/sec) for the intermediate sand and silt unit based on grain size, slug test, and pumping test data.

- The *silt unit* underlies the intermediate sand and silt unit and consists predominately of silt and very fine sand ranging in thickness from 11 to 50 feet. Near the western boundary of the RCRA facility, the upper surface of the silt unit appears to slope roughly toward the west and southwest. Laboratory triaxial tests indicated a vertical hydraulic conductivity of 10^{-7} cm/sec to 5×10^{-6} cm/sec.

- The *deep sand and silt unit* consists of sandy silt, fine sand, and interbedded lenses of silty sand. The top of the unit lies at depths of between approximately 84 and 128 feet below the ground surface (bgs). Based on the depth-to-bedrock maps compiled by Yount and colleagues (Yount et al., 1985; Yount and Gower, 1991), the thickness of the deep sand and silt unit probably increases rapidly with distance as one moves from the facility toward the Duwamish Waterway. PSC estimates a hydraulic conductivity of 3×10^{-3} cm/sec for the deep sand and silt unit based on grain size, slug test, and pumping test data.

- *Bedrock* consists of consolidated sedimentary sandstone and siltstone. At a boring east of the RCRA facility, bedrock was encountered at a depth of approximately 56 feet bgs. The depth to bedrock increases to the west and is estimated to be about 330 to 660 feet near the Duwamish Waterway (PSC, 2003).

The hydrogeologic units of primary interest include the shallow sand unit, intermediate sand and silt unit, silt unit, and the deep sand and silt unit. A generalized cross-section of the uppermost units is shown in Figure 7. The location of the cross-section in relation to surface features is shown on Figure 8. These units have been grouped into four zones: (1) the shallow zone, which includes the water table and shallow sample intervals, (2) a deeper intermediate zone that includes the "intermediate sample interval," (3) the silt aquitard, and, below the aquitard, (4) the deep aquifer.

The water table defines the top of the saturated zone of interest. The top of the silt aquitard defines the bottom of the saturated shallow/intermediate zone and appears to decline in elevation in a southwesterly direction from the RCRA facility. Beyond 5th Ave. S. to the west no borings have encountered the silt unit; this is either because borings were not deep enough or the silt was no longer present. The saturated zone of interest above the aquitard ranges in thickness from approximately 45 to 50 feet near PSC's property to 105 to 110 feet[12] approaching the Duwamish Waterway.

The shallow sand unit beneath the RCRA facility is quite distinct from the intermediate sand and silt unit. The shallow sand unit is a relatively uniform sand, whereas the intermediate sand and silt unit is recognizable by the numerous silt layers. Groundwater velocities in the intermediate sand and silt unit are much slower than those in the shallow sand unit, with velocities in the former on the order of 25 feet per year compared to velocities in the latter of 180 to 190 feet per year. However, the intermediate sand and silt unit becomes much sandier west of PSC's property, with very few silt layers identified in the boring logs west of 4th Avenue South along East Marginal Way South. This finding suggests that farther west of the RCRA facility, the shallow sand and the intermediate sand and silt units may be acting as a single hydrogeologic unit.

The deep aquifer lies beneath a silt aquitard and corresponds to the deep sand and silt unit. Beneath the RCRA facility, the depth of the deep aquifer's upper surface varies from approximately 84 feet bgs to 128 feet bgs and the unit's thickness is at least 34 feet. Based on the depth-to-bedrock map (Yount et al., 1989; Yount and Gower, 1991), the depth to bedrock is

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[12] The downgradient *zone of interest* is bounded vertically by the presence of groundwater contamination. Aquifer characterization was not conducted at depths well below the vertical extent of contamination.

expected to increase rapidly with distance as one moves westward, to about 330 to 660 feet bgs near the Duwamish Waterway.

3.1.1 Groundwater Elevations and Gradient

The general direction of groundwater flow is west-southwest from the PSC property toward the Duwamish Waterway, and shows seasonal fluctuations that are moderately well correlated to precipitation. Water levels measured in the shallow zone are similar to those in the intermediate zone, suggesting that the two zones are hydraulically well connected. Average horizontal hydraulic gradients in the water table, shallow, and intermediate sample intervals were all about 0.0016.

Groundwater elevation data from October 2008 for the water table, shallow, and intermediate sample intervals, and for the Deep Aquifer are shown on Figures 9 through 12. The influence of the barrier wall on groundwater flow in its vicinity can be seen in the groundwater elevation contours. Higher than average hydraulic gradients are observed along the northwestern and southeastern sides of the wall, and lower than average gradients are observed in a “stagnation” zone along the southwestern side of the wall. A more typical gradient, within the range of historical average gradients, appears to be reestablished within a few hundred feet downgradient of the barrier wall.

3.2 NATURE AND EXTENT OF CONTAMINATION

The primary contaminants of concern (COCs) consist of VOCs and semivolatile organic compounds (SVOCs), metals, and PCBs. These contaminants are found in soils at the RCRA facility (and immediately nearby) and in site groundwater. VOCs include compounds such as chlorinated ethenes (trichloroethene [TCE] and vinyl chloride, for example). SVOCs include 1,4-dioxane and polycyclic aromatic hydrocarbons (PAHs) (such as benzo(a)pyrene). Metals are commonly detected at sites, of course, even when there have been no releases that included metallic contaminants. At the PSC site, though, elevated levels of certain metals (such as manganese and lead) have been detected in site soils and groundwater.

3.2.1 Soil Contamination

3.2.1.1 HCIM Area Soil Contamination

Multiple investigations and monitoring activities have been conducted at and near the facility over the last 20 years. The results of those activities have been summarized in the RI Report and subsequent submittals. The most salient information concerning the distribution of contaminants and how they may affect cleanup action alternatives are described below. Soil beneath the facility is contaminated with a broad variety of substances, including VOCs,[13] SVOCs, PCBs, metals, and total petroleum hydrocarbons (TPH). Table 1 shows the individual substances that exceed applicable cleanup levels and are contaminants of concern for site soils.

The HCIM Area soils present on the TASCO, SAD, and Aronson properties are not known to be significantly impacted, except in the areas immediately adjacent to portions of the RCRA facility actively used for site operations.[14] After PSC purchased the TASCO property, available environmental information was reviewed for the TASCO property. No “recognized environmental conditions” were identified. Three USTs were located on the TASCO property historically, but these tanks were removed and soil confirmation samples collected.

PSC collected soil samples at six locations on the TASCO property in December 2007 to assess current PCB concentrations in an area near the former facility property line and outside the low-permeability concrete cap that covers most of the facility. Ecology requested this sampling and analysis in their approval of the FS. Results from a composite sample collected in this area in 1993 showed 5.1 milligrams per kilogram (mg/kg) of PCBs at 2 feet bgs and 39 mg/kg at 5 feet bgs. Results of the 2007 sampling showed similar sample results ranging from 0.88 to 62 mg/kg total PCBs. PCBs were detected at most depths at all borings; however, the highest concentrations were detected at depth greater than 3 ft and closest to the former 1993 sample location, with lower concentrations to the north and south of these locations. Groundwater sampling near this location has not historically detected elevated PCBs, indicating that the PCBs present in soil are not threatening groundwater.

3.2.1.2 Outside Area Soil Contamination

Most of the soil within the Outside Area has not been affected by RCRA facility releases. The areas of impacted soil are either on or immediately adjacent to PSC’s property. The largest area of contaminated soil in the Outside Area occurs on the UPRR Argo Yard property adjacent to PSC’s east and north property boundary. In the past PSC leased a strip of the UPRR property along the eastern PSC boundary; this area was used for drum storage in the early

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[13] As a result of implementing an SVE system in 1994, concentrations of VOCs in soil above the water table in the north field area are likely lower today than when the RI sampling in this area was performed.

[14] There are few soil data for the upper 15 feet of soil on the TASCO, Aronson, and SAD properties; however, there is also no evidence that soils in these properties have been impacted, with the exception of limited areas immediately adjacent to the facility property line.

1980s. Use of the property resulted in releases that caused soil and groundwater contamination. This area is described in detail in a separate report (Geomatrix, 2008). VOCs, SVOCs, metals, PCBs, and TPH have been detected above cleanup levels in this southwest corner of Argo Yard (please see Figures 7 through 33 of the Revised Characterization and Preferred Cleanup Approach for the Argo Yard Property report [Geomatrix, 2008].

3.2.2 Groundwater Contamination

3.2.2.1 HCIM Area Groundwater Contamination

As shown in Table 2, groundwater contaminants in the HCIM Area include VOCs, SVOCs, metals, PCBs, and TPH, the same types of substances found in soil. Contamination is present throughout the HCIM Area, within all saturated zones above the Silt Aquitard. Groundwater impacted by PCBs appears to be limited to PSC's former north field, former west field, and the central portion of the facility. Concentrations of chlorinated VOCs in groundwater west of the former north field were identified during the RI at levels indicative of the presence of dense nonaqueous phase liquid (DNAPL), particularly in wells screened in the intermediate sampling interval. Figure 13 shows the suspected DNAPL areas.[15]

3.2.2.2 Outside Area Groundwater Contamination

Groundwater in the Outside Area has also been impacted by releases from the RCRA facility. Outside Area groundwater COCs include VOCs, SVOCs, metals, and TPH, as shown in Table 2. Groundwater COCs were detected in samples collected at various depths throughout the Outside Area. As shown in Table 2, a number of contaminants exceed their cleanup levels in Outside Area groundwater. Figures 16 through 20 (based on figures from the February 2008 quarterly Progress Report) show concentrations of trichloroethene, vinyl chloride, and other COCs in groundwater at three depth intervals throughout the site. Figure 21 shows several deep aquifer COC concentrations.

Due to the large number of groundwater COCs detected, *indicator* COCs were established in the FS (Technical Memorandum No. 1, Geomatrix, 2006a). This subset of representative contaminants allowed PSC to more easily predict fate and transport and develop and evaluate remedial alternatives to comprehensively address site contamination. Outside Area indicator COCs were chosen based on their toxicity, persistence, mobility in the environment,

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[15] DNAPL has not been directly observed, but highly elevated concentrations of trichloroethene and its degradation products suggests DNAPL presence.

thoroughness of testing,[16] frequency of detection, and potential for generating hazardous degradation products. Table 3 lists the indicator substances.

3.3 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) identifying human and ecologic exposure pathways was developed in the RI Report, and further refined during the FS. It considers both the HCIM Area and the Outside Area. The CSM is shown graphically in Figure 14. The preferred cleanup action for the eastern portion of PSC's site is fundamentally linked to the site understanding, hypotheses, and assumptions described in the model.

3.3.1 HCIM Area Conceptual Site Model

The CSM for the HCIM Area is based on the statements below:

- RCRA facility operations are known to have contaminated soils and groundwater with VOCs, SVOCs, TPH, metals, and PCBs. Areas where wastes were treated, stored, or released are source areas for these COCs. Facility operations included storage and handling of materials containing these COCs in aboveground and underground tanks, piping, and drums.

- Releases from RCRA facility operations at ground surface migrated through uncovered soils and/or cracked or missing pavement into unsaturated (vadose) zone soil and then into underlying groundwater. Releases from USTs appear to have traveled directly into the saturated zone (groundwater).

- Released solvents and DNAPLs migrated down through unsaturated soils to the water table and underlying aquifer. While these solvents and DNAPLs would pool temporarily and spread out along/within the capillary fringe, the liquids eventually migrated vertically through the subsurface, reaching interbedded low-permeability silty layers and/or the silt aquitard under the PSC property. Due to the interbedded nature of the silts and sands, particularly within the Shallow and Intermediate zones, the DNAPL is likely to be broadly distributed within the vertical geologic profile as *ganglia-style* DNAPL. This is consistent with the absence of any observation of free-phase solvent, although groundwater concentrations of trichloroethene are indicative of the presence of nearby DNAPL.

- Interbedded silty features in the subsurface probably resulted in DNAPL migrating laterally past the PSC property boundary and under the adjacent TASCO property. High concentrations of solvent (primarily TCE and its degradation products) have

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[16] That is, contaminants picked as indicator substances were those that had commonly been analyzed for.

been measured in portions of the TASCO property throughout the groundwater profile down to the silt aquitard.

- The HCIM established hydraulic control of source areas, contaminated soil, and contaminated groundwater and DNAPL above the aquitard in areas behind the wall. This prevents any significant migration of contaminants in HCIM Area groundwater beyond the barrier wall.

- Groundwater extraction behind the HCIM barrier wall maintains an inward-directed hydraulic gradient for the shallow and intermediate aquifer zones, as well as the underlying Deep Aquifer. This also prevents further contaminant migration from the HCIM to Outside Areas.

- There is currently no uncovered contaminated soil within the HCIM Area.[17]

- There is currently no extraction and use of groundwater within the HCIM Area, except for the extraction that is performed to maintain an inward gradient (this extracted groundwater is treated and discharged to the public sewer). Groundwater in the HCIM Area is not a current source of drinking water and is not expected to be a drinking water source in the foreseeable future.

- There are currently no complete exposure pathways from contamination in the HCIM Area to receptors.

- In the future complete exposure pathways from contamination in the HCIM Area to receptors are possible unless the cleanup action satisfactorily addresses various potential scenarios and risks. These potential pathways include:

  a) Temporary construction workers exposed to contaminated soils. Since no contaminated soil is presently exposed within the HCIM Area, and it is not expected that soils will be exposed in the future except during construction, temporary construction workers are the primary receptor of concern for contacting soils. Construction activities may expose industrial and temporary construction workers to HCIM Area COCs via multiple pathways (direct contact with the soil, inhalation of particulates, inhalation of volatile COCs in contaminated soil gas). Temporary construction workers in the HCIM Area could be exposed to contaminated soil during installation of underground utilities; they could also be exposed to soil vapors from contaminated soils and/or groundwater within utility trenches or excavations.

  b) Office workers and visitors exposed to indoor air contamination. Indoor air contamination could be caused by vapor intrusion, resulting from the

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[17] After construction of the HCIM, surface drainage was restored, most of the buildings were demolished, and surficial debris was removed from the PSC property.

volatilization of subsurface soil or groundwater contamination. While none of the HCIM Area buildings are currently used regularly by workers or visitors, new buildings could be constructed on the property or higher occupancy activities could occur in existing buildings in the future.

c) Workers and ecological receptors exposed to soil contamination if the cap is removed. The HCIM Area is entirely paved/developed and, therefore, currently there are no significant exposures of human or ecological receptors to contaminated soils. However, if in the future the cover is removed, a number of exposure pathways become possible (direct contact, inhalation of particulates, inhalation of contaminated indoor air). It is assumed that the HCIM Area will remain in industrial or commercial use in the future. So human receptors are likely to include office workers, industrial workers, temporary construction workers, and visitors, but not permanent residents.

d) Residents exposed to soil contamination if the cap is removed. As noted above, it is assumed that the HCIM Area will remain in industrial or commercial use in the foreseeable future. However, if the cap were removed and residential use of the property occurred, a number of exposure pathways become possible (direct contact with soils, inhalation of particulates, inhalation of contaminated indoor air, ingestion of contaminated homegrown fruits or vegetables).

- Groundwater recovery and natural biodegradation reactions are expected to change the nature and distribution of groundwater COCs within the HCIM Area. Groundwater monitoring data show that reductive dechlorination reactions are active within the HCIM Area. These reactions are expected to reduce concentrations of the chlorinated organic COCs present in groundwater, although this process will be slow due to the presence of DNAPL. Monitoring data show that concentrations of nonchlorinated VOCs in groundwater are generally constant within the HCIM Area, which is expected since these constituents biodegrade very slowly under the reducing conditions that are present. Groundwater contamination behind the barrier wall will remain above cleanup levels for many years.

- Over time the barrier wall and its pumping/treatment system will require repair. Due to extreme stresses, such as earthquakes, parts of the wall could fracture.

- Over time the cap/cover in the HCIM Area will require repair.

3.3.2 Outside Area Conceptual Site Model

The CSM for the Outside Area is based on the statements below:

- There are few known areas where the concentrations of contaminants in soil outside the wall exceed cleanup levels, except on the neighboring UPRR Argo Yard property and potentially beneath the eastern portion of the SAD property.

- Prior to installation of the HCIM barrier wall, contaminated groundwater migrated from the PSC property to the west/southwest toward the Duwamish Waterway. This impacted a large area where dissolved COCs in groundwater continue to exceed applicable cleanup levels.

- Groundwater in the Outside Area discharges to the Duwamish River. A potentially complete pathway, therefore, is contaminated groundwater migration to surface water and/or sediments (in the river). Ecological receptors could be exposed to contaminated river surface water and/or sediments. Humans could be exposed to the contamination by harvesting and ingesting the ecological receptors (fish, for example).

- Some substances released from the RCRA facility and now present in Outside Area groundwater are likely to reach the Duwamish River; others are not; others may eventually reach the river but only after many years (centuries, in some cases), since their migration will be naturally "retarded" by saturated soils.

- Groundwater in the Outside Area is not a current source of drinking water. Groundwater in the Outside Area will not be used for drinking water in the foreseeable future.

  These statements apply to all site groundwater, regardless of depth. However, the "deep aquifer," groundwater present below the silt aquitard in the far eastern portion of the PSC site,[18] is proposed herein for cleanup to drinking water standards (as well as cleanup levels based on the protection of surface water).

- The shallowest groundwater in the Outside Area contains VOCs, and these contaminants pose a potential vapor intrusion threat. A potentially complete exposure pathway in the Outside Area is the inhalation of soil vapors, which have migrated from shallow groundwater up through soils into occupied buildings. This pathway is currently being mitigated by the vapor intrusion interim measure program (the IPIM).

- Currently, assuming the IPIM is and remains effective, inhalation risks and hazards due to vapor intrusion are acceptably low. Two complete exposure pathways of concern from contamination in the Outside Area to receptors are: a) migration of contaminated groundwater to the Duwamish Waterway, and exposure of receptors at that point (which for humans would be ingesting contaminated fish[19]); and,

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[18] The deep aquifer has not been found west of Denver Avenue South. This may be because borings have not been extended to sufficient depth to encounter it. Alternatively, it may "pinch-out" to the west or "merge" with what we call the "intermediate zone" at some point west of the PSC property. Characterization of the deep aquifer west of PSC's property has been minimal due to the relatively minor contamination discovered at that depth.

[19] It does not appear that releases from PSC's facility have led to exceedances of surface water cleanup levels in the Duwamish Waterway. However, contaminants associated with these releases may have reached the river.

b) temporary construction workers ("trenchers") exposed to contaminated soil vapors (via inhalation) during installation, maintenance, or repair of underground utilities in the Outside Area.

- In the future complete exposure pathways from contamination in the Outside Area to receptors are possible unless the cleanup action satisfactorily addresses various potential scenarios and risks. These potential pathways include:

  a) Temporary construction workers exposed to contaminated soil vapors (inhalation pathway) during installation of underground utilities in the Outside Area.

  b) Temporary construction (or other) workers exposed to contaminated soils in Argo Yard. Activities in uncovered areas on Argo Yard may expose industrial and construction workers to COCs via multiple pathways (direct contact with the soil, inhalation of particulates, inhalation of volatile COCs in contaminated soil gas). Temporary construction workers in the Yard could be exposed to contaminated soil during installation of underground utilities; they could also be exposed to soil vapors from contaminated soils and/or groundwater within utility trenches or excavations.

  c) Workers and ecological receptors exposed to soil contamination if the existing cover is removed. If in the future the cover is removed in Outside Areas where soil is contaminated (Argo Yard, for example), a number of exposure pathways become possible (direct contact, inhalation of particulates, inhalation of contaminated indoor air). It is assumed that these areas will remain in industrial or commercial use in the future. So human receptors are likely to include office workers, industrial workers, temporary construction workers, and visitors, but not permanent residents.

  d) Residents exposed to soil contamination if the existing cover is removed. As noted above, it is assumed that these areas will remain in industrial or commercial use in the future. However, if the covering were removed and residential use of the properties occurred, a number of exposure pathways become possible (direct contact with soils, inhalation of particulates, inhalation of contaminated indoor air, ingestion of contaminated homegrown fruits or vegetables).

  e) Residents and workers exposed to indoor air contamination. Indoor air contamination via vapor intrusion results from the volatilization of subsurface soil or groundwater contamination. While the buildings currently at risk via this pathway in the Outside Area have been mitigated,[20] new buildings could be

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[20] With the exception of several buildings where the owner did not provide access for Ecology to either sample indoor air or install a mitigation system.

constructed which do not have mitigation systems, building tenants could choose to not operate their existing mitigation systems, or existing buildings without mitigation systems could, in the future, need such systems.

f) Local residents exposed to groundwater contamination by ingesting fish contaminated by groundwater COCs that have discharged to the Duwamish Waterway.

g) Residents and workers exposed to groundwater contamination via ingestion. Groundwater is not anticipated to be a drinking water source in the foreseeable future. If, in the more distant future, however, groundwater in the Outside Area is extracted and used for drinking water, receptors could – depending on the location of the production wells, the type of treatment that was applied (if any) to the extracted water, and when (how far into the future) this use began -- be exposed to site-related contaminants.

   Likewise, if groundwater in the Outside Area is extracted in the future and used for purposes other than drinking water (for industrial cooling water or lawn watering, e.g.) without treatment, receptors could become exposed to contaminants. The type and magnitude of exposure would depend on the specific use, but would be expected to result in less of a potential health risk than routinely drinking the water.

4.0 CLEANUP STANDARDS

This section describes the cleanup standards and remediation levels for the site east of 4th. A detailed discussion of how these standards and levels were developed is included in Appendix B.

Under the state's MTCA regulations, cleanup standards consist of:

(a) **cleanup levels** for hazardous substances in environmental media that are determined by Ecology to be protective of human health and the environment under specified exposure conditions;

(b) **the location** where these cleanup levels must be met (the "point of compliance" [POC]); and

(c) other regulatory requirements that may apply, as specified under WAC 173-340-700(3)(c).[21]

4.1 POINT OF COMPLIANCE

To attain cleanup standards, cleanup levels must be achieved at the applicable point of compliance within an acceptable timeframe. The point of compliance can be established as a "standard" point of compliance (SPOC) or at an alternative location called the "conditional" point of compliance (CPOC).

The CAP establishes points of compliance for the site as follows:

- For those areas of soil contamination where containment (cover or capping) is proposed as the cleanup action, cleanup levels will not be met and there will be no formal compliance point. This is allowed under WAC 173-340-740(6)(f) as long as institutional controls are established and the other criteria of -740(6)(f)(i) through (vi) are met.

- For those areas of soil contamination where containment (cover or capping) is not proposed as the cleanup action, and where cleanup levels are based on the protection of groundwater, the POC is from ground surface to the water table (i.e., a SPOC).

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[21] Refers to requirements associated with applicable state and federal laws.

- For those areas of soil contamination where containment (cover or capping) is not proposed as the cleanup action, and where cleanup levels are based on the protection of indoor air quality, the POC is from ground surface to the water table (i.e., a SPOC).

- For those areas of soil contamination where containment (cover or capping) is not proposed as the cleanup action, and where cleanup levels are based on the protection of human exposure via direct contact, the POC is from ground surface to either the water table or a depth of 15 feet, whichever is shallower (i.e., a SPOC).

- For most groundwater the POC shall be an off-property conditional point immediately downgradient of the HCIM barrier wall. However, for contaminated groundwater upgradient of the PSC property beneath Argo Yard, an SPOC will be established. This proposal is shown on Figure 15.

- Establishment of an off-property conditional point of compliance means that for contaminated groundwater behind the barrier wall, PSC is not required to achieve cleanup levels within a reasonable timeframe as long as effective containment is maintained. To qualify for such a "point" PSC must meet the stipulated requirements of WAC 173-340-720(8)(c)(ii) (listed in Appendix B). The primary requirements include: a) demonstrating that it is not practicable to meet cleanup levels throughout the site within a reasonable timeframe; b) showing that the point chosen is "as close as practicable to the source of hazardous substances," c) demonstrating that all "practicable methods of treatment" will be used in the site cleanup[22], d) agreement by all affected property owners between the source property and the "point," and e) prior issuance of a notice proposing the "point" (with an invitation for comments).

4.2 CLEANUP LEVELS

Cleanup levels were developed by PSC and approved by Ecology in FS Technical Memorandum #1 (Geomatrix, 2006a).[23] They are presented in Tables 4 through 7 (groundwater) and 8 (soils). Cleanup levels are generally either contaminant concentrations

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[22] As well as "all known available and reasonable" methods of groundwater treatment prior to its discharge to surface water.

[23] Cleanup levels were also adjusted in 2008, as directed by Ecology. The changes accounted for Ecology's evaluation and recently-approved revision to TCE toxicity, and Ecology's Science Advisory Board's approval of Asian and Pacific Islander (fisher) risk values for use in surface water cleanup level equations.

that have been established by applicable state and/or federal laws or “risk-based” concentrations. The latter are intended to be concentrations low enough so that exposure to the contamination would not lead to unacceptable health impacts.

At the PSC site most soil cleanup levels are either concentrations that have been established by applicable state and/or federal laws or concentrations developed per MTCA Method C for industrial properties. Groundwater cleanup levels are depth specific. For contaminated groundwater at the water table, most cleanup levels are:

- concentrations that have been established by applicable state and/or federal laws,
- concentrations developed per MTCA Method B to protect surface water quality, or
- concentrations developed per MTCA Method B to protect indoor air quality, whichever is lowest.

For contaminated groundwater below the water table, most cleanup levels are:

- concentrations that have been established by applicable state and/or federal laws, or
- concentrations developed per MTCA Method B to protect surface water quality, whichever is lower.

Drinking water-based groundwater cleanup levels are not being proposed for the site cleanup except for the deepest zone, below the silt aquitard. Groundwater above the aquitard is not used for drinking water now and is presently considered nonpotable per the definitions and tests of WAC 173-340-720(2). It contains natural background concentrations of constituents that would require treatment before use as drinking water, and as a consequence, would lead to costs that make this use currently impracticable. For further information on the perceived beneficial uses of site groundwater please refer to the RI Report, Final Comprehensive Remedial Investigation Report, Part I of IV, Volume 2 of 7, Section 6; Groundwater Beneficial Use and Point of Compliance (PSC, 2003) and Ecology’s RI Report comment letter of November 9, 2004 (Ecology, 2004).

In some cases site soil or groundwater cleanup levels established as described above have been adjusted so that they are no lower than natural background concentrations or analytical detection limits (practical quantitation limits, or “PQLs”).

4.3 REMEDIATION LEVELS

Contaminant concentrations on the east side of 4th Ave. will attenuate as the groundwater they are dissolved in moves westward and eventually discharges to the river. Concentrations will attenuate due simply to dilution and dispersion, but some organic contaminants like trichloroethene, will also biodegrade, forming different chemicals. Estimating the likely degree of attenuation per substance helps us decide what kinds of action are needed and how quickly they need to be implemented.

Remediation levels (RLs) were developed to estimate groundwater contaminant concentrations that, if allowed to naturally "attenuate" (decrease in concentration)[24], would not pose an unacceptable threat to surface water quality in the Duwamish Waterway. Ecology and PSC used the RL concept to evaluate the potential applicability of *natural attenuation* as a component of the site cleanup action; i.e., if groundwater concentrations at the Outside Area POC were below RLs, natural attenuation could potentially be an effective groundwater remedy if it could also attain cleanup levels within a reasonable timeframe. If groundwater concentrations at the Outside Area POC exceeded RLs, natural attenuation by itself would not be sufficient.

RLs are not cleanup levels. Groundwater cleanup levels must be attained within a reasonable restoration timeframe at and downgradient of the Point of Compliance, regardless of when or whether RLs have been met.

The RLs are briefly described below. These RLs are all located at the CPOC. A fuller discussion of RLs is contained in Appendix B, Section 3.

Water Table Interval – TCE and vinyl chloride have the potential to reach the Duwamish Waterway. Since vinyl chloride is a breakdown product of tetrachloroethene (PCE), via intermediaries, however, RLs for PCE and cis-1,2-dichloroethene (cis-1,2-DCE) were developed in addition to those for TCE and vinyl chloride.

Shallow Interval – 1,4-Dioxane is not expected to biodegrade significantly. An RL was developed for the substance.

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[24] That is, not acted upon by any other than "natural" mechanisms.

Intermediate Interval – 1,4-Dioxane is not expected to biodegrade significantly. An RL was developed for the substance.

Deep Aquifer – COC concentrations are relatively low and RLs were not developed for the deep aquifer.

5.0 DESCRIPTION AND EVALUATION OF CLEANUP ALTERNATIVES

PSC's FS included a detailed screening and evaluation of numerous remediation technologies. Ecology determined that the screening of technologies was adequate to build specific cleanup alternatives that could then be evaluated against one another. This section describes the cleanup alternatives that were evaluated in the FS Technical Memorandum #5 (see Geomatrix, 2005, 2006a,b,c, 2007a,b; Pioneer, 2006) and summarizes the comparative analysis of alternatives.

5.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are cleanup action goals and for the PSC site were defined during the FS. Different RAOs were identified for the HCIM Area and the Outside Area due to the significant differences in soil and groundwater conditions between the two areas, differences in property ownership and accessibility, and differences in cleanup standards. General remediation objectives, as well as remediation objectives specific to the HCIM and Outside Areas, are presented below.

The general RAOs are summarized as follows:

- Prevent direct human contact with surface or subsurface soil and inhalation of dust from surface soil affected with COCs at concentrations that exceed cleanup levels, or reduce the risks associated with these exposure pathways to acceptable levels.
- Reduce risks associated with inhalation of vapors from affected soil or groundwater to acceptable levels established in accordance with MTCA regulations.
- Protect human and ecological receptors by reducing COC concentrations in Outside Area groundwater to cleanup levels based on protection of surface water.
- Attain, or otherwise comply with, the cleanup standards identified in Section 4.

The following RAOs were developed for the HCIM Area, in addition to the general objectives stated above:

- Prevent discharge of COCs from the HCIM Area at concentrations that exceed cleanup levels.
- For any actions not relying exclusively on containment, reduce contaminant concentrations in groundwater.

- Ensure that remedial actions implemented within the HCIM Area are compatible with the HCIM barrier wall.

The following RAOs were developed for the Outside Area, in addition to the general remediation objectives:

- Attain groundwater RLs at the CPOC as soon as practicable.
- Reduce constituent concentrations to achieve groundwater cleanup levels at the CPOC, and locations downgradient, within a reasonable timeframe.
- Prevent exposure of Argo Yard workers and visitors to contaminated soil, groundwater, and vapors.

5.2 IDENTIFICATION OF CLEANUP ALTERNATIVES

Cleanup alternatives were developed during the FS which could be designed to achieve the remedial action objectives for the site. The alternatives were evaluated separately in FS Technical Memorandum #5 (referred to below as "Tech Memo #5") for the HCIM Area (Alternatives HA-1 through HA-6) and the Outside Area (Alternatives OA-1 through OA-5). This section briefly summarizes the cleanup alternatives for each of these areas. Appendices C and E contain more detailed descriptions.

Ecology is not bound to choose a cleanup alternative presented in an FS report as its preferred remedy, and for the eastern portion of PSC's site the selected action – as described in Section 6 – is not identical to any of the FS alternatives discussed below. It is similar to a combination of two of the FS alternatives, but modifies aspects of these alternatives for both the HCIM and Outside Areas. The reader should also be aware that the comparative analysis provided in this section is not always in agreement with PSC's FS Tech Memo #5. Instead, it is basically the analysis Ecology used after reviewing Tech Memo #5 to identify our preferred cleanup action.

5.2.1 HCIM Area Cleanup Alternatives

The HCIM Area is defined as the area contained by the barrier wall and includes portions of the facility, the TASCO property, the Aronson Property, and the SAD property. Given the history of industrial use within and immediately adjacent to the HCIM Area and the present zoning for the area, it is expected that the future use of the HCIM Area will remain industrial.

PSC purchased the TASCO property in 2003 in order to construct the HCIM. Therefore, access to the TASCO property is no longer an issue. However, the barrier wall was constructed to contain impacted portions of the Aronson and SAD properties. In order to construct the barrier wall on these properties, easements were obtained by PSC for the SAD and Aronson properties. The easements provide PSC limited access to portions of the properties. An HCIM Area remediation alternative that can be implemented within the terms of the easements would be more readily implemented than an alternative that would require modified or additional access agreements.

The six HCIM Area alternatives are briefly discussed below. In Appendix C a much more detailed description of each alternative is presented.

HA-1	Implement no additional actions. Maintain the cap and barrier wall.[25] Allow natural attenuation to reduce groundwater concentrations behind the wall further (for those substances that will biodegrade). Continue groundwater monitoring. Establish institutional controls.[26]
HA-2	Enhance the anaerobic degradation of some contaminants in groundwater behind the wall. Maintain the cap and barrier wall. Allow natural attenuation to reduce groundwater concentrations behind the wall further (for those substances that will biodegrade). Continue groundwater monitoring. Establish institutional controls.
HA-3	Temporarily de-water the shallowest groundwater zone. Implement SVE in areas where soil VOC concentrations are elevated. Enhance the anaerobic degradation of some contaminants in groundwater behind the wall. Maintain the cap and barrier wall. Allow natural attenuation to reduce groundwater concentrations behind the wall further (for those substances that will biodegrade). Continue groundwater monitoring. Establish institutional controls.
HA-4	Temporarily de-water the shallowest groundwater zone. Implement SVE in areas where soil VOC concentrations are elevated. Reduce some contaminant mass via *in situ* chemical oxidation (ISCO) in groundwater areas behind the wall. Maintain the cap and barrier wall. Allow natural attenuation to reduce groundwater concentrations behind the wall further (for those substances that will biodegrade after pre-ISCO conditions return). Continue groundwater monitoring. Establish institutional controls.
HA-5	Implement all cleanup elements of alternative HA#3. Add an action to reduce (dissolve) DNAPLs and their associated dissolved constituents via steam injection.
HA-6	Implement all cleanup elements of alternative HA#3. Add: a) an action to reduce (dissolve) DNAPLs and their associated dissolved constituents via steam injection; b) pumping-and-treatment of contaminated groundwater; and, c) excavation and off-site disposal of some soils contaminated with PCBs and inorganic constituents.

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[25] Here and throughout this section, “maintenance” of the wall refers to the barrier wall itself as well as operation , maintenance, and repair of the gradient control system.

[26] Please see the institutional control discussion in Section 6 and Appendices C through F.

5.2.2 Outside Area Cleanup Alternatives

The Outside Area incorporates properties neighboring the facility, including UPRR (to the east of the PSC property), SAD (to the southwest of the PSC property), and Aronson (to the northwest of the PSC property). The Outside Area also includes areas extending west of the barrier wall to 4th Ave. Several sub-areas were defined within the Outside Area during the FS, as shown in Figure 4.

The five Outside Area alternatives are briefly discussed below. In Appendix E a more detailed description of each alternative is presented.

OA-1	Implement no additional actions, even in UPRR's Argo Yard. Allow natural attenuation to reduce groundwater concentrations to cleanup levels. Continue groundwater monitoring. Implement a post-Cleanup Action Plan (CAP) vapor intrusion assessment, mitigation, and mitigation operation and maintenance (O&M) program. Establish institutional controls.
OA-2	Excavate PCB-contaminated soils in Argo Yard Areas and dispose of them off-site. Cap/cover -- or ensure adequate cap/cover presently exists in -- Argo Yard areas where the remaining soil contamination exceeds cleanup levels. Conduct SVE for contaminated soils in the western part of PSC's former west field, and implement enhanced groundwater bioremediation in the same area. Allow natural attenuation to reduce groundwater concentrations to cleanup levels. Implement a post-CAP vapor intrusion assessment, mitigation, and mitigation O&M program. Continue groundwater monitoring. Establish institutional controls.
OA-3	Implement all cleanup elements of alternative OA-2. Extend the Argo Yard soil excavation action to remove additional soils where non-PCB contamination significantly exceeds cleanup levels.
OA-4	Implement all cleanup elements of alternative OA-3. Implement a groundwater pump-and-treat hydraulic control system to minimize 1,4-dioxane migration.
OA-5	Implement all cleanup elements of alternative OA-4. Supplement the groundwater pump-and-treat hydraulic control system with a 1,4-dioxane mass reduction action in a hot spot area.

5.3 COMPARATIVE ANALYSIS OF CLEANUP ALTERNATIVES

The remedial alternatives described in Section 5.2 were evaluated in the FS using the comparative analysis required by MTCA (WAC 173-340-360) and as specified in the RCRA facility permit.

5.3.1 Analysis of HCIM Area Cleanup Alternatives

Implementation of the HCIM Area alternatives would result in groundwater VOC levels being reduced, and some alternatives would lead to significant VOC reductions (especially in the shallower zones). In some cases the reductions would attain cleanup levels for certain VOCs; for other VOCs the cleanup levels would be approached. But regardless of the action taken, PSC believes it is not possible to attain cleanup levels[27] for some DNAPL-related VOCs, especially in the intermediate aquifer. Therefore, even if all other COCs were remediated to their cleanup levels, containment would still be needed to protect downgradient areas from elevated levels of COCs associated with the DNAPL. All six HCIM Area alternatives rely on long-term groundwater containment, cover/capping for contaminated soils, and institutional controls. Soil and groundwater contamination would remain at concentrations exceeding cleanup levels.

5.3.1.1 Threshold Requirements

Threshold requirements are those requirements that all alternatives must comply with if selected as the cleanup action. The ability of the six HCIM Area alternatives to meet these requirements is summarized below.

Protect human health and the environment (WAC-360(2)(a)(i))

Conclusion: All six HCIM Area (HA) alternatives would adequately protect human health and the environment as long as: a) institutional controls are effective, b) there is adequate cap/cover, and c) the barrier wall and cap are maintained/repaired, as needed, in a timely manner.

Comply with cleanup standards (360(2)(a)(ii))

When a non-permanent groundwater cleanup action (such as containment or capping) is chosen, the MTCA regulations require that treatment/removal of the source of releases be conducted for those areas contaminated with high concentrations of hazardous substances.

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[27] Outside Area groundwater cleanup levels are based primarily on surface water protection and protection of indoor air quality. Groundwater behind the wall is ¾ of a mile from the river, and some contaminants in this water would be unlikely to "reach" the river at detectable concentrations even if the wall were to be (somehow) removed. Only the shallowest groundwater contamination is a potential vapor intrusion source and threat to indoor air quality.

Source containment may be appropriate when there is DNAPL as long as reasonable efforts have been made to recover it (360(2)(c)(ii)).

None of the six alternatives will achieve all soil and groundwater cleanup levels. HA-1 does not treat/remove "the source of releases in areas with high concentrations of contaminants." Nor does it attempt to recover DNAPL. HA-2 through HA-6 attempt to treat/remove at least some of "the source of releases in areas with high concentrations of contaminants." HA-2, 3, and 4 do not attempt to "recover" DNAPL from the intermediate zone. HA-5 and 6 are designed to "recover" at least some DNAPL from both groundwater zones.

Conclusion: Groundwater behind the barrier wall is also behind the proposed Point of Compliance, so cleanup levels do not need to be attained within a reasonable restoration timeframe (i.e., the requirement to attain cleanup levels within a reasonable timeframe is not applicable). Nevertheless, HA-1's passive approach does not comply with requirements associated with this threshold criterion. HA-2 through 6 appear to meet the regulation.

Comply with applicable state and federal laws (360(2)(a)(iii)))

Conclusion: All six HA alternatives would be designed to comply with these laws.

Provide for compliance monitoring (360(2)(a)(iv))

Conclusion: All six HA alternatives would include compliance monitoring.

Use permanent solutions to the maximum extent practicable (360(2)(b)(i))

See Section 5.3.1.2 below.

Provide for a reasonable restoration timeframe (360(2)(b)(ii))

None of the alternatives will achieve all soil and groundwater cleanup levels. However, the MTCA regulations allow for the capping of soil contamination as a final remedy. If capping is chosen as part of the cleanup action there is no regulatory expectation that soil cleanup levels will be attained within a reasonable timeframe. Contaminated groundwater behind the wall is also behind the proposed POC and as such need not attain cleanup levels within a reasonable period.

Conclusion: there is no regulatory requirement for HCIM Area groundwater or soils to attain cleanup levels within a reasonable restoration timeframe if containment is the selected action.

Consider public concerns (360(2)(b)(iii))

Compliance with this requirement is generally best measured after the draft CAP has been provided to the public for comment. During the FS, PSC and Ecology can only anticipate concerns and public sentiment regarding the type of cleanup action that would be preferred based on the comments we have received in the past. In providing comments on FS Tech Memo #5 the Georgetown Community Council's consultant, Environment International (EI), stated that PSC should implement alternative HA-3.

Conclusion: HA-1 may not meet this threshold requirement. The other alternatives may meet the requirement. Ecology considers it possible, if not likely, that alternatives HA-2 through 6 would be acceptable to the public. EI's endorsement of HA-3 is a strong indication that this particular alternative would be well received by the local community.

Not primarily rely on institutional controls where it is technically possible to implement a more permanent cleanup action (360(2)(e)(iii))

Reducing COC levels in site soils and groundwater is technically possible. It is technically possible to attain some cleanup levels. Alternatives 3 through 6 could conceivably attain some cleanup levels, but not all. HA-1 and 2, which do not actively treat soil contamination, will attain fewer.

Although more aggressive cleanup can afford a higher degree of permanence (by reducing more COCs to their cleanup levels), the overall cleanup action for the HCIM Area will still need to rely on groundwater containment and institutional controls. Since the action must rely on controls even if very aggressive and expensive actions are taken to reduce many of the COCs to their cleanup levels, the practicability of achieving different degrees of permanence must be considered in selecting the optimum remedy.

Conclusion: HA-1 and 2 do not appear to meet this threshold requirement.

5.3.1.2 Evaluation Criteria

WAC 173-340-360(3) provides the regulations for "determining whether a cleanup action uses permanent solutions to the maximum extent practicable." To decide whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis is performed. This requires ranking the alternatives that meet threshold requirements from most to least permanent. If the incremental costs of an alternative over that of a less permanent, lower cost alternative exceed the incremental benefits, the added costs are "disproportionate." The preferred alternative, then, is the most permanent action whose costs are not disproportionate to cheaper, less permanent actions.

The following discusses the HCIM Area alternatives with respect to the six disproportionate cost analysis evaluation criteria:

Protectiveness (360(3)(f)(i))

This criterion includes the time the action would take to reduce risks at the facility and "the overall environmental quality" achieved. Ecology believes that HA-6 is associated with the most "protective" benefits, followed by HA-5, HA-3 and 4, HA-2, and finally HA-1. Risks to human health and the environment are only probable in the distant future,[28] but more aggressive alternatives get to lower contaminant masses quicker and thereby improve overall environmental quality faster. In some cases the improvement is not only faster but more comprehensive.

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[28] Risks could be posed in the event of a major barrier wall failure, which, while not expected, is possible. If a major failure occurred in the near future PSC would respond quickly to repair the wall and protect any receptors threatened. These receptors could be people living or working in buildings in the downgradient (Outside) area, where the buildings have not already been mitigated. If contaminated shallow groundwater from behind the barrier wall escaped and thereby contaminated shallow groundwater in the downgradient area, vapor intrusion could lead to elevated levels of some VOCs in the indoor air of unmitigated buildings.

Risks could also be posed if production wells were in the downgradient area and they became contaminated by groundwater escaping from behind the wall. However, in the near future we do not expect these types of wells to be installed or groundwater to be used for drinking water.

As time goes by and the wall ages, the probability of wall failures may increase. The statement here refers to the "distant future" because many years from now: a) failures might be more frequent or more significant (might let more groundwater escape); b) PSC or a successor liable party might not react as quickly to a wall failure; c) mitigation systems in downgradient buildings would no longer be operating; and, d) it is possible that groundwater in the area would be treated and used for drinking water, adding another potential exposure pathway should Outside Area groundwater become contaminated due to a wall failure.

Permanence (360(3)(f)(ii))

Actions that reduce more COC mass at the site are more permanent than those that reduce less. Ecology believes that HA-6 and 5 are more permanent than the other four alternatives. HA-3 and 4 are the next most permanent, followed by HA-2 and then HA-1. None of the alternatives is so permanent that containment and Institutional controls would not be necessary.

Cost (360(3)(f)(iii))

HA-1 has the lowest cost ($ 7.2 million). It is followed by HA-2 ($8.6 million), HA-3 ($9.9 million), HA-4 ($10.9 million), and HA-5 and 6 ($38.7 million and $40.1million, respectively). HA-5 and 6 are much more costly than the other four alternatives.

Long-term effectiveness (360(3)(f)(iv))

Since it employs more treatment (more reduction of contaminant mass), Ecology believes HA-6 would likely be the most effective action. HA-5 would be nearly as effective, followed by HA-3 and 4, HA-2, and HA-1. The difference between HA-1 and HA-5/6 in terms of effectiveness is substantial. The difference in effectiveness between HA-3/4 and HA-1 is also likely to be very significant.

Consideration of public concerns (360(3)(f)(vii))

As noted above, during the FS PSC and Ecology can only anticipate public sentiment regarding the type of cleanup action that would be preferred based on previous comments and discussions, and by considering the comments on Tech Memo #5 received from EI. The Department believes that HA-1 could cause public concern since it relies totally on the barrier wall and capping, and does not propose any further active treatment of contaminated groundwater or soils behind the wall. Since Ecology assumes that the public is likely to favor more treatment (permanence) versus less, HA-3 (which EI prefers), 4, 5, and 6 may all be viewed relatively favorably. HA-2 may be viewed as a less desirable action than alternatives 3 through 6 because it does not attempt to further reduce VOCs in HCIM Area soils.

Management of short-term risks (360(3)(f)(v))

The criterion of “management of short-term risks” is best applied when comparing alternatives with similar endpoints, when decision-makers must consider the “effectiveness of actions that will be taken to manage…risks." Ecology believes the six HCIM Area alternatives evaluated can be ranked about equally in terms of the ability to design them in a manner that effectively manages short term risks. All could be designed so that the risk of danger to the public and site workers was minimal.

Implementability (360(3)(f)(vi))

The implementability criterion is also best applied when comparing alternatives with similar endpoints, when decision-makers must weigh the advantages and disadvantages of alternatives that are trying to accomplish similar things. In making this comparison there is often a real difference in how technically, or administratively, implementable one option is compared to another (when neither has yet to be implemented). All six HCIM Area alternatives are both technically and administratively implementable and rely on a barrier wall that has already been constructed. Since it is easier to implement nothing than something, and generally tougher to implement more than less, HA-1 is more *implementable* than the other alternatives.

In addition to these six evaluation criteria the alternatives must be evaluated in terms of how well they achieve the regulatory requirements associated with granting a CPOC. WAC 173-340-720(8) describes the conditions under which Ecology may approve a groundwater CPOC. Ecology has agreed with PSC that it does not appear to be practicable to achieve all groundwater cleanup levels behind the barrier wall within a reasonable restoration timeframe. And we have agreed that the CPOC for groundwater should be located immediately downgradient of the barrier wall. However, use of the CPOC obligates PSC to use "all practicable[29] methods of treatment…in the site cleanup." It also requires that "groundwater discharges shall be provided with all known available and reasonable methods of treatment before being released into…" surface water.

The active treatment technologies employed in HA-2, 3, or 4 are practicable[30]. Therefore, HA-1, which does not include these technologies, is not compliant with WAC 173-340-720(8). HA-2 uses fewer active treatment technologies than HA-3 through 6 and since it does not utilize SVE, does not appear to employ "all practicable methods of treatment."

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[29] *Practicable* is defined in WAC 173-340-200. It is similar to the term *feasible*. A *practicable* treatment method is one capable of being designed, constructed, and implemented in a reliable and effective manner, "including consideration of cost."

[30] HA-5 and 6 also employ some practicable treatment technologies. They additionally employ technologies whose practicability is debatable, since they are very costly.

5.3.1.3 Selecting the Preferred Alternative for the HCIM Area

The MTCA regulations require that those alternatives which meet threshold requirements be ranked from most to least permanent. Then, if the incremental costs of a more permanent alternative over that of a lower cost/less permanent alternative exceed the incremental benefits, the added costs are deemed "disproportionate." The cheaper of the two alternatives is therefore preferable, and is compared to a third, even lower cost, still less permanent alternative. In this manner the evaluation criteria of 5.3.1.2 are utilized to select the alternative that "uses permanent solutions to the maximum extent practicable."

HA-6 is the most permanent HCIM Area action evaluated by PSC, followed by HA-5, HA-3 and 4, HA-2, and HA-1. It is also the most protective and effective over the long-term. HA-6 should therefore be chosen as the preferred remedy unless it is too costly (i.e., its costs are disproportionate to its benefits) and there is a lesser/cheaper option that meets threshold requirements more cost-effectively.

HA-6, according to PSC, will cost as much as $40.1 million. The next most permanent alternative, HA-5, could cost as much as $38.7 million, just $1.4 million less than HA-6. HA-5 does not include excavation of soil contamination hot spots or groundwater pump-and-treat to remove additional COC mass. It is debatable whether HA-5 or HA-6 is the more cost-effective action, but in either case: are the costs outweighed by the benefits of implementing these actions over the next most permanent alternatives, HA-3 and 4? HA-3 is predicted by PSC to cost $9.9 million and HA-4 $10.9 million. The analysis must therefore decide if the extra ~$29 million (the difference between HA-5/6 and HA-3/4) provides enough environmental benefit.

The HA-5 and/or 6 benefits were discussed above as we proceeded through the FS evaluation criteria. In summary they are:

- more saturated zone COC mass removal;
- more vadose zone COC mass removal (due to HA-6's excavation of soil hot spots); and,
- the potential that additional saturated zone COC mass removal may result in: a) less of a need (or no need) to implement downgradient vapor intrusion mitigation systems to protect indoor air quality in the event of future wall break; b) less of a need (or no need) to implement an action to protect surface water quality in the event of future wall break; c) less of a need (or no need) to implement an action to

protect drinking water wells in the area (should they be installed) in the event of a future wall break; and, d) less action needed (or less costly action) by a future property owner (or the public) who decides to restore the HCIM Area groundwater to cleanup levels.

These benefits (and potential benefits) have value. But they do not seem to be worth an extra $29 million. From Ecology's point of view the aggressive DNAPL remediation associated with the two alternatives (steam injection), although bound to reduce some additional COC mass, is very expensive and may be only partially effective. If costs were somewhat lower and results more certain Ecology may have concluded the benefits justified the expense.

However, it would not cost a great deal more (about $1 million) to add HA-6's excavation of soil hot spots to HA-3 or 4. This remedial element could still be considered a reasonable expectation for the preferred alternative even if the "full" HA-6 alternative is considered disproportionately costly.

If HA-5 and 6 are disproportionately costly compared to HA-3 and HA-4, the latter two must be compared to one another. Only about $1 million separates them. The benefits to implementing HA-4 are, or could be, that HA-3's enhanced biodegradation may not be as effective in reducing COC concentrations (in groundwater down to 50 feet bgs) before the first significant wall failure. That is, ISCO may act faster and be more effective (and perhaps address more COCs).

The benefits to implementing HA-3, on the other hand, are, or could be, that:

- enhanced natural attenuation may be effective in reducing COC concentrations (in groundwater down to 50 feet bgs) and perhaps before the first significant wall failure;
- it is less costly. Whether we choose HA-4 or 3, PSC will likely need to apply oxidant or enhancements repeatedly.[31] The costs of oxidant are likely to be higher than the cost of electron donor;
- administrative implementation of ISCO could be more difficult, since permission to inject a strong oxidant into groundwater would be required;

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[31] After each application we should expect rebound. Once the rebound reaches a certain level PSC will re-apply oxidant/donor. If this is required multiple times in the future, it will drive up costs and the costs of oxidant are likely to be higher than donor.

- the public may be more concerned with the addition of oxidant to groundwater than donor, even though the wall would continue to contain the treated water in any case; and,

- implementation of ISCO could result in a long "restoration" period (in terms of "restoring" reducing conditions to the water behind the wall). Until reducing conditions returned, little natural reductive dechlorination would be expected.

The fact that HA-3 is a less obtrusive action than HA-4, less costly, and capable of similar endpoints, suggests that it should be the preferable alternative.

HA-3 can then be compared to HA-2 (which is essentially HA-3 without soil vapor extraction). As noted earlier, 173-340-360(2)(e)(iii) states that the selected action cannot primarily rely on institutional controls where it is technically possible to implement a more permanent cleanup action. The HCIM Area cover/cap is not an institutional control, but use restrictions on the site due to unacceptable levels of COCs in soils below the cap are. Furthermore, reduction of VOC mass in site soils and the shallowest part of the aquifer matrix is an environmental benefit.

The benefits to implementing HA-3 are, or could be, that:

- enhanced natural attenuation (NA) may be less effective in reducing COC concentrations in shallow groundwater over the long-term unless we temporarily de-water the zone and apply SVE to it.

- removal of VOC mass from the vadose zone via SVE has significant long-term environmental value, even though the site will have a cover/cap and institutional controls will be established. The more VOC mass that is permanently removed, the less mass is left to pose vapor intrusion concerns in the HCIM Area, or further contaminate HCIM Area groundwater. In the event of a future wall failure that results in groundwater "escaping" confinement, the impact will be less severe if VOC levels in the escaping shallow groundwater are low.

- HA-2 may not adequately meet the requirements of MTCA (please see the discussion above about not relying on institutional controls, and what is required to establish a CPOC).

The benefits to implementing HA-2 (besides cost), on the other hand, are, or could be that:

- enhanced NA may be effective in reducing COC concentrations in shallow groundwater without SVE being applied; and,

- the removal of VOC mass from the vadose zone, while good for the environment, may have little "protective" value since the site will have a cover/cap and institutional controls will be applied.

HA-3 is more permanent than HA-2, more protective, and more effective. Utilization of a CPOC obligates PSC to use "all practicable methods of treatment…in the site cleanup" and SVE is a practicable treatment method. The cost difference ($1.3 million) is worth the environmental benefits, and Ecology concludes that HA-3 is a preferable alternative to HA-2.

As discussed above, HA-1 does not appear to meet threshold requirements. It does not actively "treat/remove the source of releases in areas with high concentrations of contaminants," it may be opposed by members of the public, and it relies to a large degree on institutional controls to supplement the engineered controls currently separating receptors from soil and groundwater contamination. If HA-1 were justifiable as a final remedy (i.e., if we were to conclude that it could meet threshold requirements and was sufficiently permanent), the benefits of HA-3 over HA-1 would be significant.

HA-1's primary attraction, on the other hand, is its relatively lower cost. It could cost $2.7 million less than HA-3.

5.3.2 Analysis of Outside Area Cleanup Alternatives

Five remedial alternatives were evaluated for the Outside Area (OA). All five alternatives rely to some degree on monitored natural attenuation (MNA), institutional controls, and the continued operation of a vapor intrusion assessment/mitigation program for at least another decade. Four of the five alternatives propose to protect groundwater quality by covering contaminated soils (the fifth, OA-1, does not propose any cover to protect workers or groundwater quality; it relies on controls to protect workers). None of the options propose (actively) remediating the deep aquifer, (actively) remediating elevated inorganics in groundwater, or taking active mass-reduction actions to reduce groundwater contaminant mass west of Denver Ave. (except for 1,4-dioxane).

All alternatives must comply with threshold requirements to be selected as the cleanup action. The ability of the five Outside Area alternatives to meet these requirements is summarized below.

5.3.2.1 Threshold Requirements

Protect human health and the environment (WAC-360(2)(a)(i))

Outside Area alternatives 4 and 5 will adequately protect human health and the environment as long as institutional controls and the vapor intrusion assessment/mitigation program are effective.[32] OA-2 and 3 will adequately protect health and the environment too, as long as:
a) 1,4-dioxane discharging to the river remains below surface water-based cleanup levels,
b) institutional controls are effective, and c) the vapor intrusion assessment/mitigation program remains effective. It is not clear, though, how institutional controls alone would adequately protect workers at Argo Yard from contaminated surface soils, as OA-1 proposes.

Conclusion: OA-1 is unlikely to be adequately "protective."

Comply with cleanup standards (360(2)(a)(ii))

None of the OA alternatives will achieve all soil cleanup levels. If the fate and transport modeling's predictions are reliably conservative, though, and the barrier wall performs as expected, all five alternatives may attain groundwater cleanup levels within a reasonable timeframe. Alternatives OA-4 and 5 would hasten the ultimate attainment of 1,4-dioxane cleanup levels.

Conclusion: OA-1, which does not include capping, will not comply with this requirement for contaminated soils. The other alternatives include capping and therefore do not need to meet soil cleanup levels. It is likely that OA-4 and 5 will attain all groundwater cleanup levels within a reasonable timeframe. It is less certain that OA-1, 2, and 3, which include no attempts at 1,4-dioxane mass reduction, will achieve all groundwater cleanup levels within a reasonable timeframe.

Comply with applicable state and federal laws (360(2)(a)(iii))

Conclusion: All five OA alternatives would be designed to comply with these laws.

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[32] This assumes that implementation of alternatives OA-4 and 5 would adequately protect the river.

Provide for compliance monitoring (360(2)(a)(iv))

Conclusion: All five OA alternatives would include “compliance” monitoring.

Use permanent solutions to the maximum extent practicable (360(2)(b)(i))

See Section 5.3.2.2 below.

Provide for a reasonable restoration timeframe (360(2)(b)(ii))

None of the alternatives will achieve all soil cleanup levels. But MTCA allows for soil contamination capping as a final remedy, so if this action is chosen (as proposed in alternatives OA-2, 3, 4, and 5) there is no expectation that soil cleanup levels be attained within a reasonable timeframe.[33]

For groundwater in the Outside Area, restoration timeframes per alternative were estimated during the FS to be:

OA-1

26 years to attain groundwater cleanup levels at the POC for COCs other than 1,4-dioxane and metals.

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[33] WAC 173-340-740(6)(f) explains this concept. Containment actions are perceived as having met cleanup standards as long as conditions (i) through (vi) of this regulation are met.

OA-2 and OA-3

20 years to attain groundwater cleanup levels at the POC for COCs other than 1,4-dioxane and metals.[34]

OA-4 and OA-5

20 years to attain groundwater cleanup levels at the POC for all COCs

It is less certain when: a) cleanup levels would be attained for the deep aquifer, regardless of the alternative; b) inorganic cleanup levels would be attained for groundwater in the east of 4th area, regardless of the alternative; or, c) alternatives OA-1, 2, and 3 would attain 1,4-dioxane cleanup levels throughout the FS area.

Conclusion: A 20-year timeframe for shallow and intermediate groundwater restoration downgradient of PSC appears to be "reasonable" if the contamination is not reaching the Duwamish Waterway at unacceptable levels and the vapor intrusion mitigation program is effective and maintained. The Department will solicit public input on this timeframe, and particularly from those most affected, the local property owners, residents, and workers, who must wait for concentrations to reach levels in shallow groundwater that no longer pose a vapor intrusion threat.

Ecology assumes that cleanup levels will be attained for the deep aquifer within a reasonable restoration timeframe, regardless of which alternative is chosen. Contamination in that zone is relatively minor with only modest exceedances of applicable cleanup levels. We also assume that inorganic groundwater cleanup levels in the FS area will be attained within a reasonable

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[34] In the FS, PSC utilized modeling to calculate a restoration timeframe of 20 years at the POC for COCs other than 1,4-dioxane. The model was recalibrated in 2008 using current data and assuming that the draft CAP's preferred alternative would be implemented. Using these data the timeframe increased slightly from 20 to 22 years.

When the CAP discusses the FS alternatives (OA-1 through -5) the timeframes in the FS are presented, to be consistent with PSC's FS documents. But when the cleanup action proposed for implementation is discussed, the newer timeframe (generated in 2008) is provided, since it is probably a better indication of how long it may actually take for cleanup levels to be attained throughout the area.

Estimating cleanup timeframes is inexact and must be based on some simplifying assumptions. This is especially the case when site concentrations are not already close to cleanup levels and it will take a number of years to achieve those levels. The difference, then, between an estimated 20- and 22-year timeframe is not very significant; both estimates are only best-guess predictions. The actual cleanup timeframe should be close to 20-22 years, but is likely to vary locally (from location to location) and for different COCs.

restoration timeframe, regardless of the alternative.[35] This is not expected, however, until organic contaminant levels drop so low that groundwater chemistry returns to less reducing conditions. In both cases (the deep aquifer and inorganics in the shallower zones) monitoring will tell us whether these assumptions are valid.

It is uncertain if OA-1, 2, and 3 will attain the 1,4-dioxane cleanup level throughout the east of 4th area within a reasonable restoration timeframe. It is also uncertain if any of the alternatives will achieve the vinyl chloride groundwater cleanup level throughout the east of 4th area within a reasonable restoration timeframe.

Consider public concerns (360(2)(b)(iii))

In providing comments on FS Tech Memo #5 the Georgetown Community Council's consultant, EI, stated that they believe PSC should select OA-2 (which, as proposed by PSC, does not differ substantially from OA-3). Ecology considers it likely that both alternatives OA-2 and OA-3 may be acceptable to the public. We are concerned, however, that: (1) the public would view OA-1 as essentially no action (beyond implementation of the interim action), and (2) the local community might be opposed to the construction associated with the dioxane interception action proposed in OA-4 and 5. The inconvenience to motorists associated with trenching and running underground piping from 4th Ave. to the facility may be cause for concern.

Implicit in Ecology's ranking of alternatives (below), and our agreement to limit the alternatives to the five included in Tech Memo #5, has been a belief that the local community in the affected area is satisfied with the combination of barrier wall and vapor intrusion mitigation measures implemented several years ago. By implementing the barrier wall action PSC isolated the most-heavily contaminated groundwater, stopping its spread into areas west and southwest of Denver Ave. By installing mitigation measures the company effectively protected residents and workers in the Outside Area from inhaling VOCs vaporizing from shallow groundwater. While some substances, including VOCs like TCE, remain above cleanup levels in Outside Area groundwater, in most locations downgradient of Denver Ave. they are not highly elevated. Natural attenuation should lead to further reductions in the areas where cleanup levels are exceeded, though this will take some time.

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[35] Please see Ecology's FS Tech Memo #5 comment and approval letters for the rationale behind these statements.

No actions were included in any of the OA alternatives, then, to aggressively reduce (i.e., reduce beyond the abilities of natural attenuation) VOC concentrations in Outside Area groundwater west of Denver Ave.[36] Such actions could be capable of reducing the restoration timeframe in the local areas they were implemented in. In some cases they could also shorten the time period associated with operating vapor intrusion mitigation measures. But the benefits of implementing such additional actions are off-set by their cost, and utilizing them to shorten the restoration timeframe would not improve the protectiveness of the remedy.

The public will be able to formally weigh-in on this topic during the comment period associated with the draft CAP. Ecology encourages comments from the local community (especially) on the issue of "reasonable restoration timeframe" and the Department's proposal to limit PSC's FS to the alternatives included in Tech Memo #5.

Conclusion: OA-1 is unlikely to meet this threshold requirement. Alternatives OA-4 and 5 may meet the requirement; it is difficult to tell until the public reviews the draft CAP. EI's endorsement of OA-2/3 is a strong indication that these two alternatives would be well received by the local community.

Not primarily rely on institutional controls where it's technically possible to implement a more permanent cleanup action (360(2)(e)(iii))

Reducing COC levels in contaminated soils and groundwater is technically possible. All Outside Area alternatives are predicted to eventually attain groundwater levels protective of indoor air quality, but none directly targets the current groundwater hot spots near buildings that pose vapor intrusion threats. The alternatives continue the vapor intrusion assessment/mitigation program until these cleanup levels are met. None of the alternatives is designed to attain vapor intrusion-based soil cleanup levels throughout the Argo Yard area included in the CAP.

Conclusion: OA-1 clearly does not meet this criterion for contaminated soils. OA-2, 3, 4, and 5, while more compliant, also rely heavily on controls (for soils: maintenance of cover and the vapor intrusion program; for groundwater: continuation of the vapor intrusion program until

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[36] Although the 1,4-dioxane pump and treat actions proposed in OA-4 and 5 would have had the indirect effect of reducing some VOC mass.

shallow groundwater cleanup levels are met). OA-4 and 5 are more permanent in that they reduce the mass of 1,4-dioxane in groundwater.

5.3.2.2 Evaluation Criteria

As noted above in Section 5.3.1.2, WAC 173-340-360 requires that Ecology determine which alternatives are the most permanent, how much each alternative is likely to cost, and – through use of the disproportionate cost analysis evaluation criteria – what benefits are associated with each Outside Area alternative.

Protectiveness (360(3)(f)(i))

OA-2 through 5 should be protective. OA-4 and 5 are more protective in the sense that they better protect surface water quality (they reduce the amount of 1,4-dioxane discharging to the river). OA-1 does not appear to be adequately protective.

The FS assumed that each alternative's reliance on MNA would protect the river from COC concentrations in the east of 4th area that currently exceed surface water-based cleanup levels. Each alternative requires continuation of the vapor intrusion assessment and mitigation program.

Permanence (360(3)(f)(ii))

OA-4 and 5 are designed to extract 1,4-dioxane-contaminated groundwater and destroy the dioxane contained in that water. They will therefore remove the most contaminant mass from the environment and are the most permanent alternatives. OA-2 and 3 are the next most permanent. OA-1 is the least permanent. OA-1 is much less permanent than OA-4 and 5.

Cost (360(3)(f)(iii))

OA-1 obviously has the lowest cost ($4.9 million). It is followed by OA-2 ($5.6 million), OA-3 ($7.1 million), OA-4 ($13.8 million), and OA-5 ($16.2 million).

Long-term effectiveness (360(3)(f)(iv))

OA-4 and 5 are the most effective actions since they have been designed to more reliably attain 1,4-dioxane cleanup levels. OA-3 and 2 come next; much of their effectiveness (for groundwater cleanup) depends on the effectiveness of natural attenuation. OA-1 relies most on institutional controls and is the least effective alternative.

Management of short-term risks (360(3)(f)(v))

None of the alternatives appears to lead to short-term risks that cannot be effectively mitigated.

Implementability 360(3)(f)(vi)

The large number of independent property owners and tenants could significantly complicate gaining property access to perform remediation, but all five alternatives are both technically and administratively implementable. OA-4 and 5 can reasonably be ranked lower for this criterion since they either involve running piping from 4th Ave. S. to the facility, or purchasing/leasing property near 4th. But, OA-1, 2, and 3 do not even attempt to address 1,4-dioxane with any remedial component other than dilution and dispersion.

Consideration of public concerns (360(3)(f)(vii))

Ecology ranked OA-2 and 3 highest, followed by OA-4, 5, and 1. OA-4 and 5 were ranked slightly lower than OA-2 and 3 because it was felt they might cause public concern due to related noise and traffic impacts (due to running piping for four blocks, for example). However, it is also true that if PSC chose to lease/purchase property near 4th or 5th Ave. for their 1,4-dioxane treatment system, public inconvenience would be minimized. EI has stated a preference for OA-2/3, so it may be that the public will have the least concerns about these two alternatives.

Point of Compliance (POC)

Utilizing a CPOC obligates PSC to provide “groundwater discharges…with all known available and reasonable methods of treatment before being released into…” surface water. The treatment technologies employed in OA-4 and 5 are “available” and may be “reasonable” if natural attenuation cannot quickly attain dioxane cleanup levels. None of the Outside Area alternatives includes all known available methods of treatment for groundwater contamination; this is because methods of treatment not employed by the alternatives were considered unreasonable. For example, no treatment technology other than MNA was included in OA-1 through 5 for groundwater contaminated with chlorinated VOCs west of Denver Ave. even though such technologies exist and could be implemented in the Outside Area. The FS concluded, however, that these technologies were not “reasonable” – compared to MNA – if MNA was cheaper and could achieve cleanup standards within an acceptable and comparable timeframe.

Dilution and dispersion

OA-1, 2, and 3 will only attain 1,4-dioxane cleanup levels (if at all), and protect the river, via the natural actions of dilution and dispersion. According to WAC 173-340-360(2)(g), “cleanup actions shall not rely primarily on dilution and dispersion unless the incremental costs of any active remedial measures over the costs of dilution and dispersion grossly exceed the incremental degree of benefits…” PSC’s FS did not demonstrate that the cost of treatment technologies employed in OA-4 and 5 would be **grossly** disproportionate to their benefits. OA-1, 2, and 3 are only justifiable as acceptable cleanup options, then, if they are effective and much less costly than options utilizing 1,4-dioxane treatment.

Drinking water

Ecology believes that any plans to seriously consider groundwater in the FS area for use as drinking water are many years off, and as a result PSC was allowed to limit their shallow and intermediate aquifer cleanup alternatives to those which would not be designed to attain drinking water-based cleanup levels. Nevertheless, the groundwater in this area could be seen in the future as a possible source of drinking water, once treated; so, there is *value* in hastening its restoration towards such a possible use, even if this is not the primary focus of PSC’s cleanup action.

Only OA-4 and 5 attempt to hasten the attainment of groundwater cleanup levels west of Denver Ave. by taking actions beyond MNA. None of the alternatives attempts to significantly hasten the attainment of groundwater cleanup levels for substances other than 1,4-dioxane.[37]

5.3.2.3 Selecting the Preferred Alternative for the Outside Area

As explained above, the MTCA regulations require that those alternatives which meet threshold requirements be ranked from most to least permanent. The alternative eventually selected is the one that “uses permanent solutions to the maximum extent practicable.”

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[37] Other than by implementing the proposed SVE and ISB action in PSC’s West Field. The focus of this effort would be on groundwater contamination immediately southwest of the PSC property, east of Denver Ave. S.

OA-5 is the most permanent alternative, followed by OA-4, OA-3, OA-2, and OA-1. It is also the most protective and effective over the long-term. It should therefore be chosen unless it is too costly (i.e., its costs are disproportionate) and there is a lesser/cheaper option that meets threshold requirements more cost-effectively. Ecology believes that OA-1 does not meet threshold requirements, so this leaves OA-2, 3, and 4, as viable alternatives to OA-5.

OA-5 will cost as much as $16.2 million. OA-4 could cost as much as $13.8 million, just $2.4 million less than OA-5. In our review of PSC's FS, Ecology concluded that OA-5's additional cost outweighed its benefits. OA-5's primary benefit, compared to OA-4, is that it targets a 1,4-dioxane hot spot as well as stopping the migration of dioxane past 4th Ave. S. If PSC has to operate the proposed pump-and-treat system at 4th Ave. just as long in implementing OA-4 as in OA-5 (as FS Tech Memo #5 contends), the benefits associated with OA-5 are probably outweighed by the extra cost. NOTE: In their FS PSC did not evaluate an alternative which only included a hot spot 1,4-dioxane action (i.e., an action without the 4th Ave. S. interception wells).

OA-3 is predicted to cost $7.1 million. The benefits of OA-4/5 over OA-3 are:

- Dioxane mass reduction (not just concentration attenuation).
- Faster attainment of dioxane cleanup levels.
- More certainty that groundwater levels of 1,4-dioxane within the FS area will attain the cleanup level within a reasonable restoration timeframe and not discharge to the river at concentrations greater than surface water-based cleanup levels.

Implementation of OA-4 or 5 is worth the extra $6 to $9 million <u>unless</u>: a) groundwater levels of 1,4-dioxane attain the cleanup level within a reasonable timeframe without taking any action, b) without taking any action, dioxane does not discharge to the river at concentrations greater than surface water-based cleanup levels, and c) the OA-4/5 treatment technology costs are unreasonable[38] and **<u>grossly exceed</u>** the incremental degree of benefits.

Ecology believes that OA-4 and 5 are disproportionately costly to OA-3.[39] However, we do not agree that aggressive dioxane mass treatment and reduction are *unreasonable* (as the term is

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[38] In the sense that a CPOC requires that groundwater discharges be addressed "…with all known available and reasonable methods of treatment before being released into…" surface water.

[39] Based on an <u>assumption</u> that MNA by itself could attain cleanup levels in the Outside Area.

applied in WAC 173-340-720(8)), and we do not agree that this treatment/reduction component grossly exceeds the incremental degree of the benefit unless natural attenuation by itself can be shown to quickly attain cleanup levels. So a dioxane action in the Outside Area may be needed as part of the site cleanup action, even if it is not the specific action contemplated in OA-4 or OA-5.

In comparing OA-3 to OA-2 the only consideration is whether the additional removal of contaminated soils from Argo yard is worth the price. Ecology concludes, like PSC and EI, that some extra excavation beyond what is proposed in OA-2 is worthwhile if it can be accomplished cost-effectively.

This concludes the disproportionate cost analysis since OA-1 does not meet threshold requirements.

6.0 CLEANUP ACTION

The cleanup action for the eastern portion of PSC's site is summarized in this section. This cleanup action combines the selected alternatives for the HCIM and Outside Areas and supplements the combined alternatives with additional remediation components. The following subsections summarize the proposed site-wide cleanup action, demonstrate conformance to MTCA selection criteria, outline the anticipated performance monitoring program, and describe financial assurance requirements. Key elements of the cleanup action are illustrated on Figure 5.

The cleanup action is described separately below for the HCIM and Outside Areas. However, the two Area actions comprise a comprehensive remedy addressing all contaminated media and potential exposure pathways within the CAP area. The two actions are fully compatible and will be implemented simultaneously as part of the same implementation program.

Members of the public who have reviewed PSC's FS documents, and especially FS Tech Memo #5, will see that the cleanup action discussed below is not the action preferred by PSC. Following the issuance of Tech Memo #5 and Ecology's Tech Memo #5 comment letter (July 2, 2007), Ecology and PSC discussed the pros and cons of various remedial alternatives. The action proposed below, Ecology's preferred alternative, was identified to PSC in December 2007, and PSC has agreed to implement it.

6.1 HCIM AREA CLEANUP ACTION

The HCIM Area cleanup action will continue maintenance and operation of the HCIM containment system to prevent further release of groundwater contamination to the Outside Area. It is similar to alternative HA-3 in PSC's FS. Active systems within the HCIM Area will reduce COC mass in soils and groundwater. Specifically, this twofold approach (containment and mass reduction) will include:

- The **existing barrier wall** to isolate and enclose HCIM Area impacted soils and groundwater.
- Continued operation of the **existing groundwater recovery and pretreatment system** to maintain hydraulic control and an inward groundwater gradient, preventing the release of groundwater contamination to the Outside Area.
- **Partial site dewatering** to draw the water table behind the barrier wall down two to three feet. An **SVE system** will then be installed and operated. The SVE system

will run for up to 18 months, extracting and treating volatile COCs from contaminated soils and soil gas in the HCIM Area.

While temporary drawdown will expose more of the soil column to SVE, a 2-3 foot drawdown is more cost-effective than drawing down to deeper depths due to the costs and time associated with extracting and disposing of a large quantity of contaminated groundwater.

The goal of the vapor extraction action will be to maximize VOC recovery efficiency and the cost-effectiveness of the SVE operation. An SVE 1.5-year operation timeframe is premised on the assumption that high rates of mass VOC recovery are likely to be achieved in the first year of SVE operation. After that, VOC contaminant recovery will continue, but at significantly lower (and hence, more costly than earlier) rates.

- **Active/enhanced in situ groundwater bioremediation (ISB)** to reduce levels of organic COCs. ISB will be conducted in the HCIM Area following completion of partial site dewatering and SVE. It will be performed by installing a number of injection and recirculation wells. "Electron donor" (such as molasses or lactate) will be injected into the two most contaminated groundwater areas within the HCIM Area to enhance anaerobic bioremediation and thereby reduce the mass of those organic COCs (like TCE) that degrade via this process.

  An ISB pilot test will not be required prior to full-scale implementation.

- Excavation and off-site disposal of approximately 200 cubic yards of soil on the former TASCO property that contained concentrations of polychlorinated biphenyls (PCBs) above 10 mg/kg.

- Cover/capping. HCIM areas that currently do not have capping, or are not otherwise covered, will be **paved**.

- **Institutional controls** to protect/maintain/repair the cap and HCIM barrier wall. Controls such as deed and lease restrictions will be established to limit future use of the site property and groundwater behind the wall.

- Comprehensive **financial assurance** in an amount sufficient to ensure proper performance of the remedy, and cover operations, maintenance, and repair of remedial measures for at least 100 years.

  Ecology has determined that the 100-year period is appropriate for estimating future HCIM Area remedial action costs. Costs will be revised as needed beyond the effective date of the CAP, and 100 years will remain the timeframe for estimating

> costs as long as it appears that the site's responsible party will be incurring costs this far into the future.[40] Ecology expects that the potential costs incurred this far out into the future will primarily be associated with maintaining/repairing/monitoring the barrier wall system and cap.
>
> The amount of financial assurance required by PSC will be adjusted over time as the cleanup progresses and PSC pays for the implementation of cleanup actions described in the CAP. Assurance will still need to cover costs potentially incurred 100 years out, however.[41] This will ensure that future operation, maintenance, and repair of the HCIM Area containment system is adequately funded.

The cleanup action will reduce COC mass within the HCIM Area in both soil and groundwater, but is not expected to achieve all COC cleanup levels within the foreseeable future. The existing subsurface barrier wall, constructed of earthen materials that have a very long effective life, will be relied upon to provide long-term containment of contaminated groundwater. Capping will be relied upon to provide a long-term exposure barrier to contaminated soils, and to minimize infiltration into site soils that would otherwise act to transfer soil contamination to groundwater.

To be clear, the cleanup action for the HCIM Area will **not** remediate <u>all</u> soil contamination behind the barrier wall to:

- applicable cleanup levels;
- levels that would allow "Direct Contact," although VOC (and some other) contaminant levels in some areas are likely to be reduced to concentrations below Direct Contact cleanup levels;
- levels that would protect indoor air quality if a building were to be constructed on the PSC property. VOC concentrations will be significantly reduced by SVE, however, and in some areas, and depending on the particular VOC, there will be attainment of such levels; or,
- levels that would protect underlying groundwater quality. However, SVE will result in VOC mass being significantly reduced and cover/capping will minimize infiltration.

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[40] Cost estimates developed in 2010, then, for example, would look as far out as 2110. Estimates made in 2020 would look as far out as 2120, not just 2110.

[41] Assuming that cleanup-related actions will be needed this far into the future. If at some point Ecology determines that operation, maintenance, and repair of the HCIM Area containment system, for example, can be terminated within a timeframe shorter than 100 years, associated cost estimates could be limited to this shorter timeframe.

Much of the worst soil contamination exists below a thick, dense cap that will be relied upon to shield future workers at the site from the contamination. Institutional controls will require that vapor intrusion mitigation be performed if site soil or groundwater contamination in the area where a future building is planned for construction poses a vapor intrusion threat. If precipitation or other surface water gets through the cap and mobilizes soil contamination, carrying it to the aquifer, the contaminated groundwater will still be contained by the barrier wall.

The cleanup action for the HCIM Area will **not** remediate all groundwater contamination behind the barrier wall to applicable cleanup levels. Ecology has agreed with PSC that no DNAPL treatment currently on the market is likely to be as successful as we need it to be in the HCIM Area. While we believe PSC should enhance the biodegradation of some groundwater COCs, active DNAPL treatment such as steam injection is likely to be very expensive, with no guarantee of success (attainment of cleanup levels).

The barrier wall must therefore continue to be effective in containing groundwater contamination above the aquitard. It must continue to be maintained and, when necessary, repaired. Funding must be available for maintenance and repair for decades. The ISB action proposed for implementation – and the expected continued natural attenuation of some contaminants – will reduce the concentrations of chlorinated ethenes such as TCE in shallower groundwater. This will have the benefit of making it more likely that if a wall failure occurs, the groundwater released will have minimal impact on downgradient receptors.

6.2 OUTSIDE AREA CLEANUP ACTION

The cleanup action for the Outside Area is similar to alternatives OA-2 and OA-3. It includes the following elements:

- An **SVE system** to recover and treat volatile COCs from the vadose zone. Volatile COCs include substances such as TCE, vinyl chloride, and petroleum hydrocarbons like benzene and toluene. The system will be implemented in the area extending from the HCIM barrier wall to the southwest, beneath the SAD building, and in the areas on the UPRR Argo Yard property north and northeast of the former north field. The aim of this measure is to significantly reduce the concentrations of volatile COCs in each area;

- **Excavation and off-site disposal** of COC-contaminated soils in the southwestern portion of Argo Yard where the highest levels of COCs were detected during PSC's investigations (Geomatrix, 2008);

- **Enhanced bioremediation** of groundwater on the UPRR Argo Yard property. Electron donor material will be added in the soil excavation areas if residual contaminants remain, prior to backfill;

- **Placement of a surface cover or cap over** areas of Argo Yard where soils are left in place at COC concentrations above cleanup levels;

- **Institutional controls**, including administrative and other controls, and routine public communications, to: a) restrict groundwater recovery within the Outside Area, b) limit the potential for exposure to affected soil, and c) notify the public of hazards of subsurface work conducted below the water table within designated areas. These controls will be required until groundwater and soil COC cleanup levels are attained;

- **MNA** of contaminated groundwater within the Outside Area to achieve cleanup levels at and downgradient of the CPOC within a reasonable restoration timeframe;

- Continued operation of the vapor intrusion assessment and mitigation program (now called the "**VIAM**") until VOCs in shallow groundwater and soils meet applicable cleanup levels;

- **Investigation of potential 1,4-dioxane sources** in the Outside Area. A dioxane investigation will be conducted (beginning in 2009) to determine if there are other, non-PSC sources for the contamination found in PSC's monitoring wells. A sampling and analysis plan for this investigation has already been submitted;

- **Contingent remedies** in the event that MNA is not effective in attaining cleanup levels in the Outside Area within a reasonable restoration time;

- F**inancial assurance** in an amount sufficient to ensure proper performance of the Outside Area remedy.

Based on modeling completed in the FS (2006) and later (2008)the preferred cleanup action is predicted to attain the following groundwater cleanup levels within about 22 years (by 2032):

- at the proposed CPOC,

- throughout the downgradient Outside Area east of 4th Ave. S., and

- at all depths.

Conservative fate and transport modeling has also predicted that the concentrations of VOCs currently present at the CPOC will naturally attenuate to levels below surface water cleanup levels before the groundwater they are dissolved in discharges to the Duwamish Waterway.

The cleanup action does not include remedial components for actively reducing COC levels in the Deep Aquifer. Nor have we included components in the alternative for actively reducing shallower Outside Area groundwater VOC or metals concentrations. And even though there are areas of shallow groundwater contamination west of Denver Ave. where TCE exceeds cleanup levels, we are not asking PSC to actively remediate these individual areas in order to hasten the attainment of vapor intrusion-based protective levels. In each of these cases, following review of Tech Memo #5, Ecology concluded that the benefits of active remediation were outweighed by the associated costs. But this conclusion in each case was based on the belief that the preferred alternative's more passive approach would satisfactorily attain cleanup levels within a reasonable timeframe.[42]

The cleanup action relies on controls (the VIAM program) to safeguard indoor air quality from vapor intrusion. But this reliance only extends through the time period associated with the cleanup interval. As progress is made toward attainment of cleanup levels based on vapor intrusion in shallow groundwater, controls and mitigation systems will be needed in fewer east-of-4th Ave. areas. Once shallow groundwater cleanup levels are achieved throughout the area, no controls will be needed, and mitigation systems in buildings between Denver Ave. and 4th Ave. S. will no longer be required.

The cleanup action utilizes "all known available and reasonable methods of treatment" in addressing contaminated groundwater before it is released into surface water. But a *reasonable* method of treatment is one where costs are justified by benefits, and if the benefits of natural attenuation are similar to those of a more aggressive treatment technology, and can be realized within a similar timeframe, the added cost of a more aggressive treatment technology cannot be reasonably justified. Monitoring will be used to determine if natural attenuation is attaining cleanup standards and if so, within a timeframe that could not be cost-effectively improved upon. If monitoring results indicate that some cleanup standards are not being attained, or are not being attained fast enough, PSC will be directed to implement contingent or other remedies.[43]

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[42] And that if our assumption is wrong, a contingent remedy will be implemented.

[43] Assuming, of course, that the unacceptable monitoring results indicate a failure of the cleanup action (MNA). There are other reasons why monitoring well COC concentrations may not attain cleanup levels, or seem to be attaining them too slowly. If an unknown source of contamination exists, for example, this source may be keeping COC concentrations higher than they would otherwise be.

6.3 CONTINGENT OUTSIDE AREA REMEDIES

As discussed above, groundwater contamination in the Outside Area may naturally attenuate to cleanup levels within a reasonable timeframe. However, it is also possible that: (1) the reduction in some COC concentrations will be slower than desirable, or (2) some COC concentrations will "plateau" at levels above their cleanup levels. Levels of vinyl chloride at well CG-104-I (intermediate zone), just east of Denver Ave. S., for example, remain elevated (sampling in February 2009 detected the compound at 6100 µg/l).[44] Ecology therefore required that contingent remedies be included in the CAP, and PSC must implement these remedies in the event the implemented cleanup action does not achieve expected results within anticipated timeframes. Specifically, the contingent remedies are intended to respond to scenarios where volatile or inorganic COCs, or 1,4-dioxane, in Outside Area groundwater do not appear to be attaining cleanup levels within a reasonable timeframe. In the former case the CAP is proposing an air sparging contingent remedy; in the latter case a 1,4-dioxane hot-spot pump-and-treat contingent remedy is proposed. In both cases PSC will provide financial assurance to implement the actions should the need arise.

6.3.1 Air Sparging

In the cleanup action MNA is expected to eventually achieve groundwater cleanup levels in the Outside Area. Attainment is expected at all depths: a) at the Outside Area CPOC, and b) throughout the eastern portion of the site, downgradient of the barrier wall. Groundwater modeling indicates that organic COC concentrations will achieve their cleanup levels at and downgradient of the CPOC within a little over 20 years (by about 2032). However, it is recognized that vinyl chloride, the last toxic breakdown product of PCE and TCE, or other VOCs, may either attenuate more slowly than the modeling assumes, or not attenuate all the way to applicable cleanup levels. If monitoring indicates that this is indeed happening, PSC will be expected to respond as described below. One response would be implementation of an additional action to meet remediation objectives.

For the purposes of establishing financial assurance, PSC and Ecology have assumed that a contingent remedy (an additional action) may be needed to aerate the aquifer by air sparging or a similar aeration technology. The contingent remedy would consist of multiple air sparging

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[44] Due to high levels of vinyl chloride measured at this one location, PSC installed a new monitoring well (CG-113-I) west of 104-I on the other side of Denver Ave. Samples from this well will be used to determine the *extent* of contamination associated with the 104-I "hot spot."

wells installed along the outside perimeter of the barrier wall along Denver Avenue South and/or on the UPRR Argo Yard property outside the eastern perimeter of the barrier wall. Air sparging would aerate the aquifer in this area to promote aerobic biodegradation of vinyl chloride and oxidation and precipitation of metals present in groundwater.

To help determine in the future whether MNA is performing satisfactorily, and if not, whether the contingent remedy (or some other action) should be implemented, PSC shall develop TCE and vinyl chloride cleanup level-attainment curves as part of the Engineering Design Report. The curves will be developed from existing groundwater monitoring well data and modeling results. The curves will be projected out in time to predict when the two compounds should meet cleanup levels (approximately 2032) in all Outside Areas at all depths. Comparisons to the curves will be periodically performed with monitoring data.

Ecology will review groundwater monitoring data during five-year reviews. The first such review is anticipated to be in 2015. If, during these reviews, it appears that organic COCs (such as vinyl chloride and TCE) other than 1,4-dioxane are: a) attenuating as expected, b) not posing a threat to the Duwamish Waterway, and c) attenuating to an extent such that groundwater cleanup levels will be attained by 2032, then no contingent remedy will be implemented for these COCs. Monitoring, however, will be continued until cleanup levels are attained.

If, however, Ecology concludes that some organic COC concentrations, other than 1,4-dioxane, are not attenuating as expected, or are posing a threat to the Duwamish Waterway, PSC will be directed to analyze the problem. If the problem is due to poor performance by the cleanup action (MNA), PSC will be expected to propose actions, such as implementation of the air sparging contingent remedy,[45] which should result in expeditious cleanup level attainment.

During five-year reviews Ecology will also review inorganic groundwater monitoring data. The concentrations of inorganic COCs (such as manganese, for example) are expected to attenuate over time as the groundwater geochemistry reverts to a more pre-release state. If, during these reviews, it appears that inorganic COCs are: a) attenuating as expected, b) not posing a threat to the Duwamish Waterway, and c) attenuating to an extent such that groundwater cleanup levels will be attained within a reasonable timeframe, no contingent

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[45] Air sparging will not be an effective treatment for all organic COCs, but for the contaminants most likely to pose a problem – such as vinyl chloride – it is generally capable of attaining cleanup levels.

remedy will be implemented. Monitoring, however, will be continued until cleanup levels are attained. If, however, Ecology concludes that inorganic COC concentrations are not attenuating as expected, or are posing a threat to the Duwamish Waterway, PSC will be directed to analyze the problem. If the problem is due to poor performance by the cleanup action (MNA), PSC will be expected to propose actions, such as implementation of the air sparging contingent remedy, which should result in CUL attainment.

6.3.2 1,4-Dioxane Treatment

Similarly, although the cleanup action's reliance on MNA may achieve 1,4-dioxane groundwater cleanup levels at the Outside Area CPOC and throughout the downgradient groundwater plume and at all depths within a reasonable timeframe, Ecology is not confident this will occur. Monitoring data to date show that 1,4-dioxane concentrations in the Outside Area are declining under existing conditions and that 1,4-dioxane in the downgradient plume may attenuate to cleanup levels at 4th Ave. S. within several years. However, 1,4-dioxane has also been detected at Well CG-122-60 in the last four years at concentrations of 4 to 10 times the cleanup level (Geomatrix, 2007d). Recent monitoring data show that concentrations in this well continue to be elevated.

For the purposes of establishing financial assurance, PSC and Ecology have assumed that a 1,4-dioxane contingent remedy may be needed in the area of Well CG-122-60. The contingent remedy would provide rapid 1,4-dioxane mass removal through pumping and treating impacted groundwater from a single extraction well installed in the vicinity of existing monitoring well CG-122-60. Since 1,4-dioxane has a very low sorption rate to soil, the literature indicates that the bulk of the mass can be removed by pumping two pore volumes from the single extraction well. PSC has evaluated the area of the hotspot and calculated that pumping a single well at 20 gallons per minute (gpm) for 1.3 years will remove two pore volumes of groundwater from the known hot spot area. PSC would implement this contingent remedy by installing a single extraction well and a treatment system discharging to the publicly owned treatment works (POTW).

In 2010, 1,4-dioxane monitoring data will be reviewed by PSC and Ecology. The expectation is that there will be a consistent and significant decrease in dioxane concentration at all locations and depths in the Outside Area. To help determine in 2010, or afterwards, whether the well CG-122-60 1,4-dioxane contingent remedy should be implemented, PSC shall first:

- Develop a best-fit trend curve as part of the Engineering Design Report. The curve will be developed from existing groundwater monitoring well CG-122-60 data. The trend curve will be projected out in time to predict when 1,4-dioxane will meet cleanup levels in groundwater at Well CG-122-60.[46]

- The approved trend curve will be updated thereafter with monitoring data through the end of 2009, and beyond (if required by Ecology).[47]

If in 2010 Ecology concludes that monitoring data and trend projections indicate that 1,4-dioxane concentrations will not attain cleanup levels at CG-122-60 by 2015, PSC will be directed to quickly analyze the problem. If the problem is due to poor performance by the cleanup action (MNA), PSC will propose actions, such as implementation of the contingent remedy, which should result in expeditious CUL attainment.

If, on the other hand, in 2010 it appears that 1,4-dioxane levels will be reduced to cleanup levels by 2015, the contingent remedy will not be implemented and monitoring will be continued. Ecology will review the 1,4-dioxane monitoring data periodically after that time to ensure that the rate of attenuation continues to meet expectations. If, in the future, one of these periodic reviews results in an Ecology finding that dioxane concentrations will not attain cleanup levels by 2015, the process described above will be initiated. PSC will be directed to analyze the problem and if the problem is due to poor performance by the cleanup action (MNA), PSC will be expected to propose actions, such as implementation of the contingent remedy, which should result in expeditious CUL attainment.

PSC will prepare design documents for the 1,4-dioxane contingent remedy, starting in 2010, in the event Ecology decides to require the groundwater extraction contingent action in 2010 or later.

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[46] Limiting the trend curve to only this one well is based on the assumption that once 1.4-dioxane concentrations reach cleanup levels here, they will have already reached cleanup levels in other parts of the Outside Area. If, over time, this assumption proves to be invalid, the trend analysis will need to be broadened to include more recalcitrant locations.

[47] This assumes that the trend curve predicts CUL attainment within a reasonable timeframe. A reasonable timeframe for 1,4-dioxane CUL attainment has been established as approximately five years (i.e., 2015).

6.4 MONITORING

Groundwater monitoring will be conducted under a comprehensive program that addresses both the HCIM and Outside Areas. Cleanup (and remediation) levels and measured COC concentrations will be used to assess compliance with, and the effectiveness of, the Outside Area cleanup action. Performance of the barrier wall and groundwater control program within the HCIM Area will also be monitored. Annual reporting will include an assessment of the performance of the cleanup action in meeting COC cleanup and other performance standards.

Following finalization of the CAP, PSC will prepare an Engineering Design Report (EDR). A plan documenting the specific requirements for monitoring the cleanup action will also be produced along with a long-term Operations, Inspection, Maintenance, and Monitoring Plan.

WAC 173-340-410 requires three general types of monitoring (under "Compliance Monitoring Requirements"): 1) protection monitoring, 2) performance monitoring, and 3) confirmational monitoring. The following subsections describe how these monitoring requirements will be met in implementing the proposed cleanup action.

6.4.1 Protection Monitoring

The purpose of protection monitoring is to confirm that human health and the environment are adequately protected during implementation of the cleanup action. Monitoring for this purpose will include personal monitoring of workers during construction. It will also include soil, groundwater, and vapor sampling during implementation to make sure on and off-site receptors are protected and that wastes generated are properly disposed of. The specific elements of protection monitoring will be fully described in the EDR.

6.4.2 Performance Monitoring

The purpose of performance monitoring is to confirm that the cleanup action attains its objectives and is in compliance with the CAP. Cleanup and performance standards will be developed in a Performance Monitoring Plan so that PSC and Ecology can measure compliance with the CAP and the success of the cleanup action. Performance monitoring will include:

- *Sampling residual soils after excavation* – This sampling will consist of soil samples collected from the sidewalls and/or base of each excavation area. The results will be used to measure residual COC concentrations remaining after excavation.

- *Monitoring groundwater elevations inside and outside the barrier wall to assure maintenance of the inward gradient* – This monitoring will be a continuation of the current monitoring program for the HCIM system. It uses continuous water level monitoring data from permanent transducers to verify an inward groundwater gradient. Manual measurements will also be taken routinely to verify transducer data and groundwater levels at other areas near the barrier wall.

- *Monitoring discharge groundwater from the HCIM extraction system to evaluate treatment effectiveness* – This monitoring will be a continuation of the current discharge monitoring associated with the HCIM extraction system. It is required under PSC's King County Permit. Additional components may be required based on the higher rate of extraction during the dewatering phase of remediation.

- *Long-term groundwater monitoring* – A new groundwater monitoring program will replace the existing Pre-Corrective Action Monitoring Program (PSC, 2002). The new program will be designed to monitor the effectiveness of the various elements of the cleanup action and compliance with cleanup standards. The specific details of the monitoring program will be described in the Performance Monitoring Plan.

- *Vapor inlet and outlet monitoring of the SVE systems* – Operations monitoring will be performed to ensure that the SVE systems (including treatment systems) are operating per the implementation plan, and that VOC emissions are below specified levels. Specific monitoring requirements will be described in the O&M Plan included with the EDR.

- *VIAM Monitoring* – The present vapor intrusion assessment and mitigation program (IPIM) for the east-of-4th Outside Area will be continued as long as subsurface VOC concentrations pose a threat to indoor air quality.

  No occupied buildings presently exist in the HCIM Area. If plans are made in the future to construct a building that will be occupied, PSC will either build-in measures to counteract vapor intrusion, or show that due to the building's location, size, etc., no such measures are needed.

6.4.3 Confirmational Monitoring

The purpose of confirmational monitoring is to confirm the long-term effectiveness of the cleanup action <u>once cleanup standards have been achieved</u>. This monitoring will include long-term groundwater monitoring at and beyond the Outside Area CPOC.

6.5 INSTITUTIONAL CONTROLS REQUIRED FOR ACTIONS RELYING UPON CONTAINMENT

WAC 173-340-380(a)(ix) requires that when a cleanup action relies upon on-site containment of COCs, the CAP must include specification of types, levels, and amounts of hazardous substances remaining on site and the measures that will be used to prevent migration and contact with those substances. The final cleanup action includes: a) reliance on the existing

HCIM barrier wall to contain groundwater contamination, and b) reliance on cover and capping to protect receptors from exposure to soil contamination.

Section 3.2 above summarized the COCs present behind the HCIM barrier wall in soils and groundwater. Much of the soil concentration data predates the 1994 SVE interim action. But more recent soil data collected near the perimeter of the facility continues to indicate that COCs exist well above cleanup levels in soils within the HCIM Area. Groundwater data also show that COCs exist above cleanup levels throughout the different HCIM Area groundwater zones above the aquitard. Although the remedy will reduce the total mass of volatile COCs, COC concentrations above cleanup levels will persist in both soil and groundwater within the HCIM area. In the Outside Area some contaminated soils in Argo Yard will also remain above cleanup levels (though capped/covered).

Performance monitoring will be conducted to make sure that contaminated groundwater does not migrate from the HCIM Area to the Outside Area. This monitoring will use a combination of measurements to ensure that an inward gradient is maintained and that COC concentrations in groundwater downgradient of the barrier wall attenuate as expected. Performance monitoring will be further detailed in Plans included with the EDR.

PSC negotiated property easements for access to build the barrier wall and perform maintenance on the barrier wall. The cleanup action will include maintaining those easements as an institutional control. Other institutional controls will include on-site features such as signs and fences to protect the integrity of the cap and barrier wall, and legal mechanisms, such as lease restrictions, deed restrictions, land use and zoning designations, routine notifications, and building permit requirements. Specific institutional controls will be presented in the EDR.

The cleanup action relies upon the barrier wall to contain highly contaminated groundwater east of Denver Ave. The potential exists that there will be wall failures in the future. These would be detected by the groundwater monitoring network associated with the HCIM system. Small breaks in the wall are unlikely to lead to significant downgradient contamination as long as gradient control is maintained. These breaks can then be repaired by PSC to return the wall to its specified condition. More sizable breaks, however, could contaminate downgradient groundwater, and might result from severe stresses, as would be caused by a large earthquake. PSC would then need to quickly re-gain hydraulic control to stop the further migration of HCIM Area contamination. This may require replacing sections of the wall.

Groundwater in the east-of-4th part of the PSC site is not used for drinking water and there are currently no plans to use it for this purpose. However, the cleanup action will include continued notification to the property owners in the affected area that groundwater should not be used for drinking as long as contamination exceeds drinking water standards. In addition, as a condition of approving the designation of groundwater as nonpotable in PSC's RI Report, Ecology required that PSC re-visit the nonpotability determination: a) whenever new information became available suggesting that this groundwater might be considered as a drinking water source, and b) routinely, to make sure that the impracticability of using the groundwater for drinking water remains a valid premise. With respect to this latter requirement, while Ecology has agreed that groundwater's use as drinking water in this area is not practicable now or in the foreseeable future, our decision has been based on the likely costs of treating the groundwater versus the costs of obtaining City water for the same purpose. The difference in these costs may change in the future, and as a result, the use of the groundwater as drinking water may become more or less practicable. Prior to each Ecology Five Year review,[48] therefore, PSC will prepare and submit WAC 173-340-720(2)(b)(ii) groundwater potability analyses to update the 2003 RI Report's analysis.

6.6 FINANCIAL ASSURANCE

In the past all corrective action requirements for the PSC-Georgetown site were contained in the facility permit. This included financial assurance requirements. The permit has expired and a new permit has replaced it. The new PSC permit incorporates by reference an Agreed Order which contains financial assurance requirements. These requirements are fully enforceable under the permit and the Order.

The Agreed Order requires that PSC continually update cost estimates used for financial assurance after approval of each major document in the corrective action process. These cost estimates, which are included in Appendix H, are used to determine the amount of financial assurance PSC is required to carry. Financial assurance must sufficiently cover the long-term operations, maintenance, and monitoring associated with the cleanup action and be based on third-party costs. PSC's financial assurance must sufficiently address the following:

- Operations and maintenance of all components of the proposed cleanup action, including existing components (the HCIM and vapor intrusion program) and contingent remedies;

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[48] Until groundwater in the Outside Area attains drinking water standards.

- Long term compliance monitoring, including reporting;
- Significant repair of the HCIM barrier wall due to failure as the result of an earthquake. An earthquake of sufficient magnitude to cause significant wall failures has been assumed to occur once every 50 years; and
- 100-year timeframe for costing, as discussed in Section 6.1.

PSC's financial assurance obligations are not limited to the eastern portion of their site. Financial assurance must be provided to meet cleanup costs for the entire site area.

7.0 IMPLEMENTATION OF THE PROPOSED CLEANUP ACTION

The CAP has summarized the cleanup action alternatives evaluated in the FS, identified the cleanup and remediation levels for site hazardous substances, and identified – generally – the institutional controls that will be needed (which will be further specified in the EDR). It has described the proposed cleanup action and summarized the rationale for its selection.

The CAP will be implemented in accordance with its associated Agreed Order and the process and approach required by the MTCA regulations (WAC 173-340-400). PSC will initiate work on the design phase of the project, including preparation of an EDR consistent with WAC 173-340-400(4)(a) and Construction Plans and Specifications (CPS) consistent with WAC 173-340-400(4)(b). The EDR will include all components of the selected remedy, including contingent remedies specified in the CAP. It will therefore include:

- An MNA monitoring/performance plan for contaminated groundwater in both the HCIM Area and Outside Area;
- Remedial design and action documents associated with the Argo Yard SVE action;
- Remedial design and action documents associated with the HCIM Area SVE action;
- Remedial design and action documents associated with the "West Field" (Outside Area) SVE action;
- Remedial design and action documents associated with the HCIM Area ISB action;
- Remedial design and action documents associated with HCIM Area de-watering;
- Remedial design and action documents associated with soil excavation and enhanced bioremediation in Argo Yard; and,
- Remedial design and action documents associated with capping (paving) activities in Argo Yard and the HCIM Area.

The EDR will include a detailed implementation plan, design concepts and objectives, and a preliminary implementation schedule. The implementation schedule will include a critical-path Gantt chart timeline showing anticipated dates and timeframes for all post-CAP deliverables and cleanup action elements. The EDR will include the CPS, a preliminary Operation and Maintenance Plan, a Construction Health and Safety Plan, a Performance Monitoring Plan (or plans), and a Construction Quality Assurance Plan as attachments. The CPS document will include design drawings and specifications sufficient to proceed with construction, and a detailed cost estimate. All permits necessary to complete the cleanup will be identified and included in the CPS. The EDR and attachments will be submitted to Ecology for review and comment and, once approved, finalized.

The cleanup action will be implemented in a phased approach. The HCIM system and vapor intrusion program are currently in place and operational as is much of the monitoring system that will be needed. Although many of the components can be installed concurrently, others cannot be completed, or at least placed into operation, until preceding remedies are completed. The following represents the most likely sequence of events in implementing the CAP:

1. Maintain the HCIM system and the IPIM vapor intrusion program as currently operated and as appropriate to maintain effectiveness and address known risks.

2. Adjust financial assurance to cover costs associated with implementation of the CAP (as well as likely costs associated with cleanup of contamination west of 4th Ave. S.).

3. Develop and implement all necessary institutional controls.

4. Implement the planned excavation, soil disposal, and enhanced bioremediation on the UPRR and/or PSC property and pave those areas requiring capping.

5. Install any needed additional monitoring wells. Commence groundwater performance monitoring for the Outside Area.

6. Increase the rate of groundwater extraction/dewatering to the maximum capacity of the existing HCIM system to lower the water table within the HCIM Area.

7. After 3 to 6 months of dewatering (with the goal of dropping the water table 2 to 3 feet), implement SVE in the HCIM Area. Also implement SVE in locations along the SAD property line and on the UPRR Argo Yard property.

8. Monitor the SVE system. It is expected to take up to 1.5 years to achieve asymptotic VOC conditions. During that time shutdown of the system and re-starting to address rebound may be required.

9. Implement ISB in the HCIM Area following completion of SVE and recovery of groundwater levels.

10. Install appropriate surface cover to cover contaminated soil in HCIM areas not already covered.
11. Commence groundwater performance monitoring for the HCIM Area.

The above timeline is intended to summarize the general implementation plan anticipated for the preferred final cleanup action. The implementation timeline may need to be changed during final engineering, and if so, the changes will be proposed to Ecology in the EDR.

After completing the construction outlined in the EDR and CPS, PSC will prepare and submit: (1) a revised long-term operation, inspection, maintenance, and monitoring plan (O&M Plan), and (2) construction documentation. The O&M Plan will meet the requirements of WAC 173-340-400(4)(c) and will document procedures for operation of all remediation components. A cleanup implementation report (as-built report) will also be prepared to document construction completed for implementation of the EDR. The implementation report will be prepared in accordance with WAC 173-340-400(5)(b) and will include as-built drawings, specifications, and documentation for implementation of institutional controls. A revised financial cost estimate will be included in the cleanup implementation report with a copy of a revised financial assurance document. For the purposes of the table below, the O&M Plan and As-Built Report were assumed to be submitted once, following the completion of all construction. However, the EDR may choose to establish multiple Plans and Reports specific to particular elements of the cleanup action. In this case each set of Plans and Reports would typically be submitted to Ecology following completion of the specific element (ISB, for example) they related to.

The milestone schedule for the cleanup action is as follows (following page):

Action/deliverable	Start date	End/Due date
Draft EDR/CPS		6 months following finalization of the CAP
Draft Final EDR/CPS		45 days following receipt of Ecology's comments on the draft EDR/CPS
Final EDR/CPS		30 days following receipt of Ecology's comments on the draft final EDR/CPS
Commence construction per the approved EDR's schedule	Six months following approval of the Final EDR/CPS	
Implement institutional controls per the approved EDR and its schedule		One year following finalization of the CAP
Draft 1,4-dioxane source investigation SAP		(already submitted)
Revised 1,4-dioxane source investigation SAP		30 days following receipt of Ecology's comments on the draft SAP
Implement 1,4-dioxane source investigation SAP	Per the schedule in the approved SAP	
Revised Long-term Operation, Inspection, Maintenance, and Monitoring Plan (O&M Plan), and As-built Report		Per the schedule in the approved EDR
Draft Final Long-term Operation, Inspection, Maintenance, and Monitoring Plan (O&M Plan), and construction documentation		45 days following receipt of Ecology's comments on the revised O&M Plan and As-built Report
Report: Analysis of 1,4-dioxane trends at Well 122-60		November 1, 2010
Ecology "Five year" reviews		Every five years following finalization of the CAP

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TABLES

TABLE 1

SOIL CONSTITUENTS OF CONCERN

PSC Georgetown Facility
Seattle, Washington

1,1,1-Trichloroethane	Cyanide
1,1-Dichloroethane	Dibenzofuran
1,1-Dichloroethene	Diesel range hydrocarbons
1,2,4-Trimethylbenzene	Di-n-butyl phthalate
1,2-Dichlorobenzene	Di-n-octyl phthalate
1,2-Dichloroethane	Ethylbenzene
1,3,5-Trimethylbenzene	Gasoline range hydrocarbons
2,4-Dimethylphenol	Indeno(1,2,3-cd)pyrene
2-Hexanone	Lead
2-Methylnaphthalene	Lube oil range hydrocarbons
2-Methylphenol	Mercury
4-Methylphenol	Methyl isobutyl ketone (MIBK)
Acetone	Methylene chloride
Aroclor 1242	Naphthalene
Aroclor 1254	n-Butylbenzene
Aroclor 1260	Nickel
Arsenic	Pentachlorophenol
Barium	Phenanthrene
Benzene	Phenol
Benzo(a)anthracene	p-Isopropyltoluene
Benzo(a)pyrene	Propylbenzene
Benzo(b)fluoranthene	sec-Butylbenzene
Benzo(k)fluoranthene	Selenium
Benzoic acid	Silver
Bis(2-ethylhexyl) phthalate	Styrene
Cadmium	Tetrachloroethene
Chloroform	Toluene
Chromium	trans-1,3-Dichloropropene
Chrysene	Trichloroethene
cis-1,2-Dichloroethene	Vinyl chloride
cis-1,3-Dichloropropene	Xylenes (Total)
Copper	Zinc
Cumene	n-Propylbenzene*

Note: List of constituents of concern is based on Table 3-4 of Technical Memorandum No. 1 (Geomatrix, 2006a), except for constituents identified with an asterisk, which were identified based on review and screening of data collected on the UPRR Argo Yard.

TABLE 2

GROUNDWATER CONSTITUENTS OF CONCERN [1]

PSC Georgetown Facility
Seattle, Washington

Constituent [2]	HCIM Area			Outside Area			
	Water Table Depth Interval	Shallow Depth Interval	Intermediate Depth Interval	Water Table Depth Interval	Shallow Depth Interval	Intermediate Depth Interval	Deep Aquifer
1,1,1-Trichloroethane	X	X	X	X			
1,1,2-Trichlorotrifluoroethane	X						
1,1-Dichloroethane	X	X	X	X	X	X	
1,1-Dichloroethene	X		X				
1,2,4-Trimethylbenzene	X		X	X			
1,2-Dichlorobenzene	X		X	X			
1,2-Dichloroethane	X	X					
1,3,5-Trimethylbenzene	X			X			
1,4-Dichlorobenzene	X			X			
1,4-Dioxane	X				X	X	
1-Methylnaphthalene	X			X*			
2,4-Dimethylphenol	X		X	X*			
2-Hexanone	X	X					
2-Methylnaphthalene	X			X*			
2-Methylphenol	X		X	X*			
4-Methylphenol	X		X	X*			
Aroclor 1016	X						
Aroclor 1232	X						
Aroclor 1242				X*	X*	X*	
Aroclor 1248				X*			
Aroclor 1254				X*			
Aroclor 1260				X*			
Arsenic	X		X	X	X	X	X
Barium	X		X	X	X	X	X
Benzene	X	X	X	X	X		
Benzo(a)anthracene	X				X	X	
Benzo(a)pyrene				X*			
Benzo(b)fluoranthene	X				X	X	
Benzo(ghi)perylene				X*			
Benzo(k)fluoranthene	X				X	X	
Benzyl alcohol					X*	X*	
Bis(2-ethylhexyl) phthalate				X	X	X	X
Benzoic acid	X						
Butyl benzyl phthalate				X*			
C10-C12 (EPH) Aromatics	X			X			
C8-C10 (EPH) Aliphatics	X						
C8-C10 (EPH) Aromatic	X			X			
C8-C10 (VPH) Aromatics	X			X			
Carbon disulfide	X	X	X			X	X
Chloroethane	X	X		X			
Chloroform	X			X			
Chloromethane				X*			
Chromium	X		X	X	X*	X	X

TABLE 2

GROUNDWATER CONSTITUENTS OF CONCERN [1]

PSC Georgetown Facility
Seattle, Washington

	HCIM Area			**Outside Area**			
Constituent [2]	**Water Table Depth Interval**	**Shallow Depth Interval**	**Intermediate Depth Interval**	**Water Table Depth Interval**	**Shallow Depth Interval**	**Intermediate Depth Interval**	**Deep Aquifer**
Chrysene	X			X*	X	X	X
cis-1,2-Dichloroethene	X	X	X	X			
Copper	X		X	X	X	X	X
Cumene	X			X			
Cyanide	X	X	X	X*	X	X	
Dibenzo(a,h)anthracene	X			X	X	X	
Dichlorodifluoromethane	X			X			
Diesel range hydrocarbons	X		X				X
Ethylbenzene	X	X	X	X		X	
Gasoline range hydrocarbons	X						
Hexavalent Chromium					X		X
Indeno(1,2,3-cd)pyrene	X			X	X	X	
Iron		X	X	X	X	X	X
Lead	X		X	X*	X*	X	
Lube oil range hydrocarbons	X		X				
Manganese	X		X	X	X	X	X
Methyl isobutyl ketone (MIBK)	X	X					
Methylphenol	X						
Naphthalene	X			X	X		
n-Hexane	X			X			
Nickel	X		X	X	X*	X	X
n-Propylbenzene				X*	X*		
Pentachlorophenol	X						
Phenol	X		X	X*			
Propylbenzene	X			X			
sec-Butylbenzene	X			X			
Selenium							X
Silver							X
Styrene	X		X	X			
Tetrachloroethene	X	X	X	X			X
Toluene	X	X	X	X			
trans-1,2-Dichloroethene	X		X				
Trichloroethene	X	X	X	X	X		X
Vanadium			X			X	X
Vinyl chloride	X	X	X	X	X	X	X
Xylenes (Total)	X	X	X	X			
Zinc					X*	X*	X

Notes:

1. List of constituents is based on Table 3-5 of Technical Memorandum No. 1 (Geomatrix, 2006a), except for constituents identified with an asterisk, which were identified based on review and screening of data collected on the UPRR Argo Yard.
2. EPH = Extractable petroleum hydrocarbons;
   VPH = Volatile petroleum hydrocarbons.

TABLE 3

GROUNDWATER INDICATOR SUBSTANCES BY DEPTH INTERVAL[1]

PSC Georgetown Facility
Seattle, Washington

Water Table Depth Interval
PCE
TCE
cis-1,2-DCE
VC
Ethylbenzene
Toluene
Shallow Depth Interval
1,4-Dioxane
PCE
TCE
cis-1,2-DCE
VC
Benzene
Intermediate Depth Interval
1,4-Dioxane
PCE
TCE
cis-1,2-DCE
VC
Ethylbenzene
Deep Aquifer
None

Notes:

1. PCE = tetrachloroethene;
TCE = Trichloroethene;
cis- 1,2-DCE = *cis* -1,2-dichloroethene;
VC = vinyl chloride.

TABLE 4

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - WATER TABLE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Indoor Air (µg/L)**	**Basis of Protection of Indoor Air**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
1,1,1-Trichloroethane	5,526	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1,095	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	11	ORNL	--	--	0.5	11	Ecological RA: ORNL	NA	**11**	**NA**
1,1,2-Trichlorotrifluoroethane	61,404	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1,209	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	11,000	USGS 1999	--	--	0.5	1,209	Method B - Residential GW to Air	NA	**1209**	**NA**
1,1-Dichloroethane	2,303	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	752	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	47	ORNL	--	--	0.5	47	Ecological RA: ORNL	NA	**47**	**NA**
1,1-Dichloroethene	987	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	53.2	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	25	ORNL	7100	AWQC Federal Human Health Consumption of Organisms Only	0.02	25	Ecological RA: ORNL	NA	**25**	**NA**
1,2,4-Trimethylbenzene	64.3	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	13.0	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	400	AQUIRE	--	--	1	13	Method B - Residential GW to Air	450	**13**	**NA**
1,2-Dichlorobenzene	179	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1,119	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	14	ORNL	1300	AWQC Federal Human Health Consumption of Organisms Only	0.5	14	Ecological RA: ORNL	31.6	**31.6**	**NA**
1,2-Dichloroethane	25.3	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	12.9	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	910	ORNL	37	AWQC Federal Human Health Consumption of Organisms Only	0.045	12.9	Method B - Residential GW to Air	NA	**12.9**	**NA**
1,3,5-Trimethylbenzene	46.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	9.8	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	400	AQUIRE	--	--	1	9.8	Method B - Residential GW to Air	190	**9.76**	**NA**
1,4-Dichlorobenzene	2.1	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	3,505	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	15	ORNL	190	AWQC Federal Human Health Consumption of Organisms Only	0.133	2.1	Method B Modified - API Fisher	3.2	**3.2**	**NA**
1,4-Dioxane	78.5	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	--	--	0.1	78.5	Method B Modified - API Fisher	NA	**78.5**	**NA**
1-Methylnaphthalene	3.16	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	**2.1**	**NA**
2-Hexanone	1,922	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	609	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	99	ORNL	--	--	20	99	Ecological RA: ORNL	NA	**99**	**NA**
2-Methylphenol	877	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	13	ORNL	--	--	0.5	13	Ecological RA: ORNL	NA	**13**	**NA**
2,4-Dimethylphenol	23.6	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	131	AQUIRE	400	AWQC Federal Organoleptic Effect Criteria	2	23.6	Method B Modified - API Fisher	NA	**23.6**	**NA**
2-Methylnaphthalene	42.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	**2.1**	**NA**
4-Methylphenol	89.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	1000	AQUIRE	--	--	0.5	89.1	Method B Modified - API Fisher	NA	**89.1**	**NA**

TABLE 4

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - WATER TABLE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Indoor Air (µg/L)**	**Basis of Protection of Indoor Air**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
Aroclor 1016	0.000248	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	176	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	0.014	State AWQC	0.000064	AWQC Federal Human Health Consumption of Organisms Only	0.005	0.005	PQL	NA	**0.005**	**NA**
Aroclor 1232	0.0000443	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	22.9	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	0.014	State AWQC	0.000064	AWQC Federal Human Health Consumption of Organisms Only	0.005	0.005	PQL	NA	**0.005**	**NA**
Aroclor 1242[1]	0.0000443	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	22.9	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	0.014	State AWQC	0.000064	AWQC Federal Human Health Consumption of Organisms Only	0.005	0.005	PQL	NA	**0.005**	**NA**
Arsenic	0.0419	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	36	State AWQC	0.14	AWQC Federal Human Health Consumption of Organisms Only	0.03/0.5	0.0419	Method B Modified - API Fisher	NA	**0.05**	**NA**
Barium	12.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	4	ORNL	--	--	0.05	4	Ecological RA: ORNL	NA	**4**	**NA**
Benzene	9.66	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	9.60	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	130	ORNL	51	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.60	Method B - Residential GW to Air	21.1	**9.6**	**NA**
Benzo(a)anthracene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.027	ORNL	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	NA	**0.02**	**NA**
Benzo(b)fluoranthene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0194	0.0194	PQL	NA	**0.0194**	**NA**
Benzo(k)fluoranthene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0134	0.018	AWQC Human, Organism Only	NA	**0.018**	**NA**
Benzoic acid	27,981	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	42	ORNL	--	--	5	42	Ecological RA: ORNL	NA	**42**	**NA**
Bis(2-ethylhexyl) phthalate	1.52	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	3	ORNL	2.2	AWQC Federal Human Health Consumption of Organisms Only	2	2	PQL	24.7	**24.7**	**NA**
C10-C12 (EPH) Aromatics	--	--	9.09	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	--	--	--	--	50	50	PQL	NA	**528**	**NA**
C8-C10 (EPH) Aliphatics	--	--	1.08	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	--	--	--	--	50	50	PQL	NA	**50**	**NA**
C8-C10 (EPH) Aromatics	--	--	275	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	--	--	--	--	50	275	Method B - Residential GW to Air	NA	**120**	**NA**
C8-C10 (VPH) Aromatics	--	--	275	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	--	--	--	--	50	275	Method B - Residential GW to Air	NA	**120**	**NA**
Carbon disulfide	1,783	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	145	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	0.92	ORNL	--	--	0.5	0.92	Ecological RA: ORNL	NA	**0.92**	**NA**
Chlorobenzene	215	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	51.9	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	64	ORNL	1600	AWQC Federal Human Health Consumption of Organisms Only	0.5	51.9	Method B - Residential GW to Air	NA	**51.9**	**NA**

TABLE 4

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - WATER TABLE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	Protection of Surface Water (µg/L)	Basis of Protection of Surface Water	Protection of Indoor Air (µg/L)	Basis of Protection of Indoor Air	Protection of Surface Water (µg/L)	Basis of Protection of Surface Water	ARAR (µg/L)	Basis of ARAR	Practical Quantitation Limit (µg/L)	Preliminary Groundwater Cleanup Level (µg/L)	Basis of Preliminary Groundwater Cleanup Level	Site-Specific Cleanup Level (µg/L)	Final Cleanup Level (µg/L)	Remediation Level (µg/L)
Chloroethane	381	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	5,437	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	230,000	USGS 1999	--	--	0.5	381	Method B Modified - API Fisher	NA	**381**	**NA**
Chloroform	295	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	4.11	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	28	ORNL	470	AWQC Federal Human Health Consumption of Organisms Only	0.5	4.11	Method B - Residential GW to Air	18.2	**4.11**	**NA**
Chromium	--	--	--	--	10	State AWQC	74	AWQC Federal Freshwater CCC	0.2	10	Ecological RA: State AWQC	NA	**10**	**NA**
Chrysene	0.180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0124	0.018	AWQC Human, Organism Only	NA	**0.018**	**NA**
cis-1,2-Dichloroethene	136	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	72.7	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	11,600	USGS 1999	--	--	0.5	72.7	Method B - Residential GW to Air	NA	**72.7**	**310**
Copper	114	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	3.1	State AWQC	3.1	AWQC Federal Saltwater CCC	0.1	3.1	Ecological RA: State AWQC	NA	**3.1**	**NA**
Cumene	85.0	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	74.9	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	7.3	ORNL	--	--	2	7.3	Ecological RA: ORNL	120	**74.9**	**NA**
Cyanide	2,211	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	1	State AWQC	1	AWQC Federal Saltwater CMC	10	10	PQL	NA	**10**	**NA**
Dibenzo(a,h)anthracene	0.00451	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0162	0.0162	PQL	0.0667	**0.0667**	**NA**
Dichlorodifluoromethane	2,403	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	6.36	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	--	AQUIRE	--	--	0.5	6.36	Method B - Residential GW to Air	NA	**6.36**	**NA**
Diesel range hydrocarbons	--	--	--	--	--	--	--	--	100	500	Method A	NA	**500**	**NA**
Ethylbenzene	295	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1,262	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	7.3	ORNL	2100	AWQC Federal Human Health Consumption of Organisms Only	0.5	7.3	Ecological RA: ORNL	1,300	**1,262**	**NA**
Gasoline range hydrocarbons	--	--	--	--	--	--	--	--	130	800	Method A	NA	**800**	**NA**
Hexavalent Chromium	20.7	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	10	State AWQC	10	WA State WAC 173-201A Freshwater Chronic	0.2	10	Ecological RA: State AWQC	NA	**10**	**NA**
Indeno(1,2,3-cd)pyrene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	0.0616	**0.0616**	**NA**
Iron	--	--	--	--	--	--	1000	AWQC Federal Saltwater CCC	20	1000	AWOQC Federal Saltwater CCC	NA	**1,000**	**NA**
Lead	--	--	--	--	2.5	State AWQC	2.5	AWQC Federal Freshwater CCC	0.02	2.5	Ecological RA: State AWQC	NA	**2.5**	**NA**
Lube oil range hydrocarbons	--	--	--	--	--	--	--	--	NA	500	Method A	NA	**500**	**NA**

TABLE 4

GROUNDWATER CLEANUP AND REMEDIATION LEVELS -
WATER TABLE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Indoor Air (µg/L)**	**Basis of Protection of Indoor Air**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
Manganese	1,613	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	120	ORNL	100	AWQC Federal Human Health Consumption of Organisms Only	0.05	100	AWQC Human, Organism Only	NA	**100**	**NA**
Methyl isobutyl ketone (MIBK)	4,421	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	104,397	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	170	ORNL	--	--	18	170	Ecological RA: ORNL	NA	**170**	**NA**
Methylene chloride	409	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	321	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	2,200	ORNL	590	AWQC Federal Human Health Consumption of Organisms Only	1	321	Method B - Residential GW to Air	NA	**321**	**NA**
Methylphenol	--	--	--	--	1,650	AQUIRE	--	--	0.5	1,650	Ecological RA: AQUIRE	NA	**1,650**	**NA**
Naphthalene	211	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	59.2	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	12	ORNL	--	--	2	12	Ecological RA: ORNL	192	**59.2**	**NA**
n-Hexane	33.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	0.450	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	0.58	ORNL	--	--	1	1	PQL	2.3	**0.45**	**NA**
Nickel	47.0	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	8.2	State AWQC	8.2	AWQC Federal Saltwater CCC	0.2	8.2	Ecological RA: State AWQC	NA	**8.2**	**NA**
Pentachlorophenol	2.1	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	7.9	State AWQC	3	AWQC Federal Human Health Consumption of Organisms Only	0.283	2.1	Method B Modified - API Fisher	NA	**2.53**	**NA**
Phenol	23,684	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	118	AQUIRE	300	AWQC Federal Organoleptic Effect Criteria	0.196	118	Ecological RA: AQUIRE	NA	**118**	**NA**
p-Isopropyltoluene	--	--	74.9	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	10,000	AQUIRE	--	--	1	74.9	Method B - Residential GW to Air	NA	**74.9**	**NA**
Propylbenzene	29.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	26.9	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	7.3	ORNL	--	--	0.98	7.3	Ecological RA: ORNL	190	**26.9**	**NA**
sec-Butylbenzene	3.80	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	23.1	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	490	USGS 1999	--	--	1	3.80	Method B Modified - API Fisher	10	**10**	**NA**
Selenium	115	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	5	State AWQC	5	AWQC Federal Freshwater CCC	1	5	Ecological RA: State AWQC	NA	**5**	**NA**
Styrene	597	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	3,646	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	0.06	AQUIRE	--	--	0.5	0.5	PQL	15	**15**	**NA**
Tetrachloroethene	0.17	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	5.01	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	98	ORNL	3.3	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.17	Method B Modified - API Fisher	NA	**0.2**	**16**
Toluene	2,066	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	496	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	9.8	ORNL	15000	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.8	Ecological RA: ORNL	9,040	**496**	**NA**

TABLE 4

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - WATER TABLE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Indoor Air (µg/L)**	**Basis of Protection of Indoor Air**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
trans-1,2-Dichloroethene	1,399	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	65.3	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	11,600	USGS 1999	10000	AWQC Federal Human Health Consumption of Organisms Only	0.5	65.3	Method B - Residential GW to Air	NA	**65.3**	**NA**
Trichloroethene	2.93	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	1.82	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	47	ORNL	30	AWQC Federal Human Health Consumption of Organisms Only	0.02	1.82	Method B - Residential GW to Air	NA	**1.82**	**27**
Vanadium	242	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	20	ORNL	--	--	0.2	20	Ecological RA: ORNL	NA	**20**	**NA**
Vinyl chloride	1.69	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	1.28	Residential MTCA Method B - 750-2 Inhalation of Indoor Air	11,600	USGS 1999	2.4	AWQC Federal Human Health Consumption of Organisms Only	0.02	1.28	Method B - Residential GW to Air	NA	**1.28**	**145**
Xylenes (Total)	116	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	144	Residential MTCA Method B - 750-1 Inhalation of Indoor Air	20,000	AQUIRE	--	--	0.5	116	Method B Modified - API Fisher	4,654	**116**	**NA**
Zinc	705	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	--	--	81	State AWQC	81	AWQC Federal Saltwater CCC	0.5	81	Ecological RA: State AWQC	NA	**81**	**NA**

Notes:

1. Values for Aroclor 1232 were used for Arcolor 1242 cleanup levels because values for Aroclor 1242 are not currently available in Ecology's Cleanup Levels and Risk Calculations Database.

Revised since FS.
-- = No value was available
API Fisher = Asian Pacific Islander Fisherman
AQUIRE = U.S. EPA AQUIRE Database - available on-line at http://www.epa.gov/ecotox/
ARAR - Applicable of Relevant and Appropriate Requirements
AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)
CUL - Cleanup Levels
EPH - Extractable Petroleum Hydrocarbons
GW - Groundwater
MTCA = Model Toxics Control Act (WAC 173-340)
NA = Not applicable.
ORNL = Oak Ridge Nation Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota - http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html and go to screening benchmark reports
PQL - Practical Quantification Limit
RA - Risk Assessment
Residential GW to Air - Residential MTCA Method B 750-2/750-1
State AWQC = WAC 173-201A - Water Quality Standards for Surface Waters of the State of Washington
USGS 1999 = United States Geological Survey - Selection Procedure and Salient Information for Volatile Organic Compounds Emphasized in National Water Quality
VPH - Volatile Petroleum Hydrocarbons
WAC - Washington Administrative Code

Notes: (cont)

TABLE 5

GROUNDWATER CLEANUP AND REMEDIATION LEVELS -
SHALLOW DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk		Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
1,1,1-Trichloroethane	5,526	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11	ORNL	--	--	0.5	11	Ecological RA: ORNL	NA	11	NA
1,1-Dichloroethane	2,303	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	47	ORNL	--	--	0.5	47	Ecological RA: ORNL	NA	47	NA
1,1-Dichloroethene	987	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	25	ORNL	7,100	AWQC Federal Human Health Consumption of Organisms Only	0.02	25	Ecological RA: ORNL	NA	25	NA
1,2,4-Trimethylbenzene	64.3	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	400	AQUIRE	--	--	1	64.3	Method B Modified - API Fisher	NA	64.3	NA
1,2-Dichloroethane	25.3	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	910	ORNL	37	AWQC Federal Human Health Consumption of Organisms Only	0.045	25.3	Method B Modified - API Fisher	NA	25.3	NA
1,3,5-Trimethylbenzene	46.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	400	AQUIRE	--	--	1	46.1	Method B Modified - API Fisher	NA	46.1	NA
1,4-Dioxane	78.5	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.1	78.5	Method B Modified - API Fisher	NA	78.5	128
1-Methylnaphthalene	3.16	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	2.1	NA
2,4-Dimethylphenol	23.6	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	131	AQUIRE	400	AWQC Federal Organoleptic Effect Criteria	2	23.6	Method B Modified - API Fisher	NA	23.6	NA
2-Hexanone	1,922	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	99	ORNL	--	--	20	99	Ecological RA: ORNL	NA	99	NA
2-Methylnaphthalene	42.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	2.1	NA
2-Methylphenol	877	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	13	ORNL	--	--	0.5	13	Ecological RA: ORNL	NA	13	NA
Aroclor 1242[1]	0.0000443	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.014	State AWQC	0.000064	AWQC Federal Human Health Consumption of Organisms Only	0.005	0.005	PQL	NA	**0.005**	**NA**
Arsenic	0.04	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	36	State AWQC	0.14	AWQC Federal Human Health Consumption of Organisms Only	0.03/0.5	0.04	Method B Modified - API Fisher	NA	0.04	NA
Barium	12.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	4	ORNL	--	--	0.05	4	Ecological RA: ORNL	NA	4	NA
Benzene	9.7	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	130	ORNL	51	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.7	Method B Modified - API Fisher	30	30	NA
Benzo(a)anthracene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.027	ORNL	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	0.0317	0.0317	NA
Benzo(b)fluoranthene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0194	0.0194	PQL	0.0273	0.0273	NA
Benzo(k)fluoranthene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0134	0.018	AWQC Human, Organism Only	0.0369	0.0369	NA
Bis(2-ethylhexyl) phthalate	1.52	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	3	ORNL	2.2	AWQC Federal Human Health Consumption of Organisms Only	2	2	PQL	7.11	7.11	NA
Carbon disulfide	1,783	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	0.92	ORNL	--	--	0.5	0.92	Ecological RA: ORNL	NA	0.92	NA
Chloroethane	381	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	230,000	USGS 1999	--	--	0.5	381	Method B Modified - API Fisher	NA	381	NA

TABLE 5

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - SHALLOW DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

Constituent	Human Health Risk		Ecological Risk		ARAR		Practical Quantitation Limit (µg/L)	Preliminary Groundwater Cleanup Level (µg/L)	Basis of Preliminary SWFS Groundwater Cleanup Level	Site-Specific Cleanup Level (µg/L)	Final Cleanup Level (µg/L)	Remediation Level (µg/L)
	Protection of Surface Water (µg/L)	Basis of Protection of Surface Water	Protection of Surface Water (µg/L)	Basis of Protection of Surface Water	ARAR (µg/L)	Basis of ARAR						
Chromium	--	--	10	State AWQC	74	AWQC Federal Freshwater CCC	0.2	10	Ecological RA: State AWQC	NA	10	NA
Chrysene	0.180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0124	0.018	AWQC Human, Organism Only	0.0338	0.0338	NA
cis-1,2-Dichloroethene	136	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11,600	USGS 1999	--	--	0.5	136	Method B Modified - API Fisher	NA	136	NA
Copper	114	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	3.1	State AWQC	3.1	AWQC Federal Saltwater CCC	0.1	3.1	Ecological RA: State AWQC	NA	3.1	NA
Cumene	85.0	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	7.3	ORNL	--	--	2	7.3	Ecological RA: ORNL	NA	7.3	NA
Cyanide	2,211	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1	State AWQC	1	AWQC Federal Saltwater CMC	10	10	PQL	11.8	11.8	NA
Dibenzo(a,h)anthracene	0.00451	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0162	0.0162	PQL	0.0291	0.0291	NA
Diesel range hydrocarbons	--	--	--	--	--	--	100	500	Method A	NA	500	NA
Ethylbenzene	295	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	7.3	ORNL	2,100	AWQC Federal Human Health Consumption of Organisms Only	0.5	7.3	Ecological RA: ORNL	NA	7.3	NA
Gasoline range hydrocarbons	--	--	--	--	--	--	130	800	Method A	NA	800	NA
Hexavalent chromium	20.7	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	10	State AWQC	10	WA State WAC 173-201A Freshwater Chronic	0.2	10	Ecological RA: State AWQC	NA	10	NA
Indeno(1,2,3-cd)pyrene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	0.0254	0.0254	NA
Iron	--	--	--	--	1,000	AWQC Federal Saltwater CCC	20	1,000	AWQC Federal Saltwater CCC	NA	1,000	NA
Lead	--	--	2.5	State AWQC	2.5	AWQC Federal Freshwater CCC	0.02	2.5	Ecological RA: State AWQC	NA	2.5	NA
Manganese	1,613	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	120	ORNL	100	AWQC Federal Human Health Consumption of Organisms Only	0.05	100	AWQC Human, Organism Only	NA	100	NA
Methylene chloride	409	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	2,200	ORNL	590	AWQC Federal Human Health Consumption of Organisms Only	1	409	Method B Modified - API Fisher	NA	409	NA
Methyl isobutyl ketone (MIBK)	4,421	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	170	ORNL	--	--	18	170	Ecological RA: ORNL	NA	170	NA
Naphthalene	211	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	12	ORNL	--	--	2	12	Ecological RA: ORNL	27.2	27.2	NA
Nickel	47.0	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	8.2	State AWQC	8.2	AWQC Federal Saltwater CCC	0.2	8.2	Ecological RA: State AWQC	NA	8.2	NA
Pentachlorophenol	2.1	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	7.9	State AWQC	3	AWQC Federal Human Health Consumption of Organisms Only	0.283	2.1	Method B Modified - API Fisher	NA	2.53	NA
Phenol	23,684	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	118	AQUIRE	300	AWQC Federal Organoleptic Effect Criteria	0.196	118	Ecological RA: AQUIRE	NA	118	NA
p-Isopropyltoluene	--	--	10,000	AQUIRE	--	--	1	10,000	Ecological RA: AQUIRE	NA	10,000	NA
Propylbenzene	29.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	7.3	ORNL	--	--	0.98	7.3	Ecological RA: ORNL	NA	7.3	NA
sec-Butylbenzene	3.80	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	490	USGS 1999	--	--	1	3.80	Method B Modified - API Fisher	NA	3.80	NA

TABLE 5

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - SHALLOW DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk		Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (μg/L)**	**Basis of Protection of Surface Water**	**Protection of Surface Water (μg/L)**	**Basis of Protection of Surface Water**	**ARAR (μg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (μg/L)**	**Preliminary Groundwater Cleanup Level (μg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Site-Specific Cleanup Level (μg/L)**	**Final Cleanup Level (μg/L)**	**Remediation Level (μg/L)**
Selenium	115	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	5	State AWQC	5	AWQC Federal Freshwater CCC	1	5	Ecological RA: State AWQC	NA	5	NA
Tetrachloroethene	0.2	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	98	ORNL	3.3	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.2	Method B Modified - API Fisher	NA	0.20	NA
Toluene	2,066	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	9.8	ORNL	15,000	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.8	Ecological RA: ORNL	NA	9.8	NA
trans-1,2-Dichloroethene	1,399	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11,600	USGS 1999	10,000	AWQC Federal Human Health Consumption of Organisms Only	0.5	1,399	Method B Modified - API Fisher	NA	1,399	NA
Trichloroethene	2.9	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	47	ORNL	30	AWQC Federal Human Health Consumption of Organisms Only	0.02	2.9	Method B Modified - API Fisher	NA	2.9	NA
Vanadium	242	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	20	ORNL	--	--	0.2	20	Ecological RA: ORNL	NA	20	NA
Vinyl chloride	1.7	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	11,600	USGS 1999	2.4	AWQC Federal Human Health Consumption of Organisms Only	0.02	1.7	Method B Modified - API Fisher	NA	1.7	NA
Xylenes (Total)	116	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	20,000	AQUIRE	--	--	0.5	116	Method B Modified - API Fisher	NA	116	NA
Zinc	705	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	81	State AWQC	81	AWQC Federal Saltwater CCC	0.5	81	Ecological RA: State AWQC	NA	81	NA

Notes:

1. Values for Aroclor 1232 were used for Arcolor 1242 cleanup levels because values for Aroclor 1242 are not currently available in Ecology's Cleanup Levels and Risk Calculations Database.

Revised since FS.

-- = No value was available
API Fisher = Asian Pacific Islander Fisherman
AQUIRE = U.S. EPA AQUIRE Database - available on-line at http://www.epa.gov/ecotox/
ARAR - Applicable of Relevant and Appropriate Requirements
AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)
CCC = Criteria Continuous Concentration
CMC = Criteria Maximum Concentration
CUL = Cleanup Level
GW - Groundwater
MTCA = Model Toxics Control Act (WAC 173-340)
NA = Not applicable.
ORNL = Oak Ridge Nation Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota - http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html and go to screening benchmark reports
PQL - Practical Quantification Limit
RA - Risk Assessment
State AWQC = WAC 173-201A - Water Quality Standards for Surface Waters of the State of Washington
SW - Surface Water
USGS 1999 = United States Geological Survey - Selection Procedure and Salient Information for Volatile Organic Compounds Emphasized in National Water Quality
WAC - Washington Administrative Code

TABLE 6

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - INTERMEDIATE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk		**Ecological Risk**		**ARAR**							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
1,1,1-Trichloroethane	5,526	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11	ORNL	--	--	0.5	11	Ecological RA: ORNL	NA	11	NA
1,1-Dichloroethane	2,303	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	47	ORNL	--	--	0.5	47	Ecological RA: ORNL	68	68	NA
1,1-Dichloroethene	987	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	25	ORNL	7100	AWQC Federal Human Health Consumption of Organisms Only	0.02	25	Ecological RA: ORNL	NA	25	NA
1,2,4-Trimethylbenzene	64.3	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	400	AQUIRE	--	--	1	64.3	Method B Modified - API Fisher	NA	64.3	NA
1,2-Dichlorobenzene	179	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	14	ORNL	1300	AWQC Federal Human Health Consumption of Organisms Only	0.5	14	Ecological RA: ORNL	NA	14	NA
1,2-Dichloroethane	25.3	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	910	ORNL	37	AWQC Federal Human Health Consumption of Organisms Only	0.045	25.3	Method B Modified - API Fisher	NA	25.3	NA
1,4-Dioxane	78.5	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	--	--	0.1	78.5	Method B Modified - API Fisher	NA	78.5	128
1-Methylnaphthalene	3.16	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	2.1	NA
2-Methylnaphthalene	42.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	2.1	NA
2-Methylphenol	877	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	13	ORNL	--	--	0.5	13	Ecological RA: ORNL	NA	13	NA
2,4-Dimethylphenol	23.6	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	131	AQUIRE	400	AWQC Federal Organoleptic Effect Criteria	2	23.6	Method B Modified - API Fisher	NA	23.6	NA
4-Methylphenol	89.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1,000	AQUIRE	--	--	0.5	89.1	Method B Modified - API Fisher	NA	89.1	NA
Aroclor 1242[1]	0.0000443	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.014	State AWQC	0.000064	AWQC Federal Human Health Consumption of Organisms Only	0.005	0.005	PQL	NA	**0.005**	**NA**
Arsenic	0.04	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	36	State AWQC	0.14	AWQC Federal Human Health Consumption of Organisms Only	0.03/0.5	0.04	Method B Modified- API Fischer	NA	0.04	NA
Barium	12.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	4	ORNL	--	--	0.05	4	Ecological RA: ORNL	NA	4	NA
Benzene	9.7	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	130	ORNL	51	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.7	Method B Modified - API Fisher	NA	9.7	NA
Benzo(a)anthracene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.027	ORNL	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	0.0294	0.0294	NA
Benzo(b)fluoranthene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0194	0.0194	PQL	0.0316	0.0316	NA
Benzo(k)fluoranthene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0134	0.018	AWQC Human, Organism Only	0.0384	0.0384	NA
Benzoic acid	27,981	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	42	ORNL	--	--	5	42	Ecological RA: ORNL	NA	42	NA

TABLE 6

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - INTERMEDIATE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

Constituent	Human Health Risk		Ecological Risk		ARAR		Practical Quantitation Limit (µg/L)	Preliminary Groundwater Cleanup Level (µg/L)	Basis of Preliminary SWFS Groundwater Cleanup Level	Specific Cleanup Level (µg/L)	Final Cleanup Level (µg/L)	Remediation Level (µg/L)
	Protection of Surface Water (µg/L)	Basis of Protection of Surface Water	Protection of Surface Water (µg/L)	Basis of Protection of Surface Water	ARAR (µg/L)	Basis of ARAR						
Bis(2-ethylhexyl) phthalate	1.52	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	3	ORNL	2.2	AWQC Federal Human Health Consumption of Organisms Only	2	2	PQL	9.51	9.51	NA
Carbon disulfide	1,783	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	0.92	ORNL	--	--	0.5	0.92	Ecological RA: ORNL	2.6	2.6	NA
Chloroethane	381	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	230,000	USGS 1999	--	--	0.5	381	Method B Modified - API Fisher	NA	381	NA
Chromium	--	--	10	State AWQC	74	AWQC Federal Freshwater CCC	0.2	10	Ecological RA: State AWQC	NA	10	NA
Chrysene	0.180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0124	0.018	AWQC Human, Organism Only	0.0451	0.0451	NA
cis-1,2-Dichloroethene	136	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11,600	USGS 1999	--	--	0.5	136	Method B Modified - API Fisher	NA	136	NA
Copper	114	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	3.1	State AWQC	3.1	AWQC Federal Saltwater CCC	0.1	3.1	Ecological RA: State AWQC	NA	3.1	NA
Cyanide	2,211	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	1	State AWQC	1	AWQC Federal Saltwater CMC	10	10	PQL	3.8	3.8	NA
Dibenzo(a,h)anthracene	0.00451	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.016	0.016	PQL	0.0425	0.0425	NA
Diesel range hydrocarbons	--	--	--	--	--	--	100	500	Method A	NA	500	NA
Ethylbenzene	295	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	7.3	ORNL	2100	AWQC Federal Human Health Consumption of Organisms Only	0.5	7.3	Ecological RA: ORNL	36.4	36.4	NA
Gasoline range hydrocarbons	--	--	--	--	--	--	130	800	Method A	NA	800	NA
Indeno(1,2,3-cd)pyrene	0.0180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	0.0431	0.0431	NA
Iron	--	--	--	--	1000	AWQC Federal Saltwater CCC	20	1,000	AWQC Ecological	NA	1,000	NA
Lead	--	--	2.5	State AWQC	2.5	AWQC Federal Freshwater CCC	0.02	2.5	Ecological RA: State AWQC	NA	2.5	NA
Lube oil range hydrocarbons	--	--	--	--	--	--	NA	500	Method A	NA	500	NA
Manganese	1,613	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	120	ORNL	100	AWQC Federal Human Health Consumption of Organisms Only	0.05	100	AWQC Human Health, Organism Only	NA	100	NA
Methylene chloride	409	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	2,200	ORNL	590	AWQC Federal Human Health Consumption of Organisms Only	1	409	Method B Modified - API Fisher	NA	409	NA
Naphthalene	211	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	12	ORNL	--	--	2	12	Ecological RA: ORNL	NA	12	NA
n-Hexane	33.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	0.58	ORNL	--	--	1	1	PQL	NA	1	NA
Nickel	47.0	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	8.2	State AWQC	8.2	AWQC Federal Saltwater CCC	0.2	8.2	Ecological RA: State AWQC	NA	8.2	NA
Pentachlorophenol	2.1	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	7.9	State AWQC	3	AWQC Federal Human Health Consumption of Organisms Only	0.283	2.1	Method B Modified - API Fisher	NA	2.10	NA
Phenol	23,684	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	118	AQUIRE	300	AWQC Federal Organoleptic Effect Criteria	0.196	118	Ecological RA: AQUIRE	NA	118	NA

TABLE 6

GROUNDWATER CLEANUP AND REMEDIATION LEVELS - INTERMEDIATE DEPTH INTERVAL

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk		Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
Propylbenzene	29.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	7.3	ORNL	--	--	0.98	7.3	Ecological RA: ORNL	NA	7.3	NA
Selenium	115	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	5	State AWQC	5	AWQC Federal Freshwater CCC	1	5	Ecological RA: State AWQC	NA	5	NA
Styrene	597	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	0.06	AQUIRE	--	--	0.5	0.5	PQL	NA	0.5	NA
Tetrachloroethene	0.167	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	98	ORNL	3.3	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.17	Method B Modified - API Fisher	NA	0.17	NA
Toluene	2,066	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	9.8	ORNL	15000	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.8	Ecological RA: ORNL	NA	9.8	NA
trans-1,2-Dichloroethene	1,399	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11,600	USGS 1999	10000	AWQC Federal Human Health Consumption of Organisms Only	0.5	1,399	Method B Modified - API Fisher	NA	1,399	NA
Trichloroethene	2.9	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	47	ORNL	30	AWQC Federal Human Health Consumption of Organisms Only	0.02	2.9	Method B Modified - API Fisher	NA	2.90	NA
Vanadium	242	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	20	ORNL	--	--	0.2	20	Ecological RA: ORNL	NA	20	NA
Vinyl chloride	1.7	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	11,600	USGS 1999	2.4	AWQC Federal Human Health Consumption of Organisms Only	0.02	1.7	Method B Modified - API Fisher	4,390	4,390	NA
Xylenes (Total)	116	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	20,000	AQUIRE	--	--	0.5	116	Method B Modified - API Fisher	NA	116	NA
Zinc	705	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	81	State AWQC	81	AWQC Federal Saltwater CCC	0.5	81	Ecological RA: State AWQC	NA	81	NA

Notes:

1. Values for Aroclor 1232 were used for Arcolor 1242 cleanup levels because values for Aroclor 1242 are not currently available in Ecology's Cleanup Levels and Risk Calculations Database.

Revised since FS.
-- = No value was available
API Fisher = Asian Pacific Islander Fisherman
AQUIRE = U.S. EPA AQUIRE Database - available on-line at http://www.epa.gov/ecotox/
ARAR - Applicable of Relevant and Appropriate Requirements
AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)
CCC = Criteria Continuous Concentration
CMC = Criteria Maximum Concentration
CUL = Cleanup Level
GW - Groundwater
MTCA = Model Toxics Control Act (WAC 173-340)
NA = Not applicable.
ORNL = Oak Ridge Nation Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota - http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html and go to screening benchmark reports
PQL - Practical Quantification Limit
RA - Risk Assessment
State AWQC = WAC 173-201A - Water Quality Standards for Surface Waters of the State of Washington
SW - Surface Water
USGS 1999 = United States Geological Survey - Selection Procedure and Salient Information for Volatile Organic Compounds Emphasized in National Water Quality
WAC - Washington Administrative Code

TABLE 7

GROUNDWATER CLEANUP AND REMEDIATON LEVELS - DEEP AQUIFER
PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Drinking Water Criteria (µg/L)**	**Basis of Drinking Water Criteria**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
1,2-Dichloroethane	25.3	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.48	MTCA Method B - 720-2	910	ORNL	37	AWQC Federal Human Health Consumption of Organisms Only	0.045	0.48	Method B Drinking Water	NA	0.48	NA
1-Methylnaphthalene	3.16	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	0.24	MTCA Method B - 720-1	2.1	ORNL	--	--	0.02	0.24	Method B Drinking Water	NA	0.24	NA
2-Methylnaphthalene	42.1	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	3.2	MTCA Method B - 720-1	2.1	ORNL	--	--	0.02	2.1	Ecological RA: ORNL	NA	2.1	NA
Arsenic	0.04	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.058	MTCA Method B - 720-2	36	State AWQC	0.14	AWQC Federal Human Health Consumption of Organisms Only	0.03/0.5	0.04	Method B Modified - API Fisher	NA	0.04	NA
Barium	12.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	112	MTCA Method B - 720-1	4	ORNL	--	--	0.05	4	Ecological RA: ORNL	NA	4	NA
Benzo(b)fluoranthene	0.018	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.017	MTCA Method B - 720-2	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0194	0.0194	PQL	NA	0.0194	NA
Benzo(k)fluoranthene	0.018	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.017	MTCA Method B - 720-2	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0134	0.017	AWQC Human Health	NA	0.018	NA
Bis(2-ethylhexyl) phthalate	1.52	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	6.25	MTCA Method B - 720-2	3	ORNL	2.2	AWQC Federal Human Health Consumption of Organisms Only	2	2	PQL	2.06	2.06	NA
Carbon disulfide	1,783	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	80	MTCA Method B - 720-1	0.92	ORNL	--	--	0.5	0.92	Ecological RA: ORNL	6.2	6.2	NA
Chloroform	294.7	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	8.0	MTCA Method B - 720-1	28	ORNL	470	AWQC Federal Human Health Consumption of Organisms Only	0.5	8	Method B Drinking Water	NA	8	NA
Chromium	--	--	--	--	10	State AWQC	74	AWQC Federal Freshwater CCC	0.2	10	Ecological RA: State AWQC	NA	10	NA
Chrysene	0.180	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.171	MTCA Method B - 720-2	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.0124	0.018	AWQC Human Health	0.273	0.171	NA
cis-1,2-Dichloroethene	136	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	8.0	MTCA Method B - 720-1	11600	USGS 1999	--	--	0.5	8	Method B Drinking Water	NA	8	NA
Copper	114	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	59.2	MTCA Method B - 720-1	3.1	State AWQC	3.1	AWQC Federal Saltwater CCC	0.1	3.1	Ecological RA: State AWQC	NA	3.1	NA
Dibenzo(a,h)anthracene	0.005	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.004	MTCA Method B - 720-2	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	NA	0.02	NA
Diesel range hydrocarbons	--	--	--	--	--	--	--	--	100	500	Method A	NA	500	NA

TABLE 7

GROUNDWATER CLEANUP AND REMEDIATON LEVELS - DEEP AQUIFER

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Drinking Water Criteria (µg/L)**	**Basis of Drinking Water Criteria**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
Gasoline range hydrocarbons	--	--	--	--	--	--	--	--	130	800	Method A	NA	800	NA
Hexavalent Chromium	20.7	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	4.8	MTCA Method B - 720-1	10	State AWQC	10	WA State WAC 173-201A Freshwater Chronic	0.2	4.8	Method B Drinking Water	NA	4.8	NA
Indeno(1,2,3-cd)pyrene	0.018	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.017	MTCA Method B - 720-2	--	--	0.018	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.02	PQL	NA	0.02	NA
Iron	--	--	480	MTCA Method B - 720-1	--	--	1000	AWQC Federal Saltwater CCC	20	480	Method B Drinking Water	NA	480	NA
Lead	--	--	--	--	2.5	State AWQC	2.5	AWQC Federal Freshwater CCC	0.02	2.5	Ecological RA: State AWQC	NA	2.5	NA
Manganese	1,613	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	74.7	MTCA Method B - 720-1	120	ORNL	100	AWQC Federal Human Health Consumption of Organisms Only	0.05	74.7	Method B Drinking Water	NA	74.7	NA
Methane	--	--	--	--	--	--	--	--	0.5	--	--	NA	NA	NA
n-Hexane	33.2	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	48	MTCA Method B - 720-1	0.58	ORNL	--	--	1	1	PQL	NA	1	NA
Nickel	47.0	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	32	MTCA Method B - 720-1	8.2	State AWQC	8.2	AWQC Federal Saltwater CCC	0.2	8.2	Ecological RA: State AWQC	NA	8.2	NA
Selenium	115	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	8.0	MTCA Method B - 720-1	5	State AWQC	5	AWQC Federal Freshwater CCC	1	5	Ecological RA: State AWQC	NA	5	NA
Silver	1,105	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	8.0	MTCA Method B - 720-1	1.9	State AWQC	1.9	AWQC Federal Saltwater CMC	0.02	1.9	Ecological RA: State AWQC	NA	1.9	NA
Styrene	597	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	160	MTCA Method B - 720-1	0.06	AQUIRE	--	--	0.5	0.5	PQL	NA	0.5	NA
Tetrachloroethene	0.167	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.081	MTCA Method B - 720-2	98	ORNL	3.3	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.081	Method B Drinking Water	NA	0.081	NA
Toluene	2066	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	160	MTCA Method B - 720-1	9.8	ORNL	15000	AWQC Federal Human Health Consumption of Organisms Only	0.5	9.8	Ecological RA: ORNL	NA	9.8	NA
Total extractable petroleum hydrocarbons	--	--	--	--	--	--	--	--	NA	NA	--	NA	NA	NA
Trichloroethene	2.93	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.24	MTCA Method B - 720-1	47	ORNL	30	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.24	Method B Drinking Water	NA	0.24	NA
Vanadium	242	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	11.2	MTCA Method B - 720-1	20	ORNL	--	--	0.2	11.2	Method B Drinking Water	NA	11.2	NA

TABLE 7

GROUNDWATER CLEANUP AND REMEDIATON LEVELS - DEEP AQUIFER

PSC Georgetown Facility
Seattle, Washington

	Human Health Risk				Ecological Risk		ARAR							
Constituent	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**Drinking Water Criteria (µg/L)**	**Basis of Drinking Water Criteria**	**Protection of Surface Water (µg/L)**	**Basis of Protection of Surface Water**	**ARAR (µg/L)**	**Basis of ARAR**	**Practical Quantitation Limit (µg/L)**	**Preliminary Groundwater Cleanup Level (µg/L)**	**Basis of Preliminary SWFS Groundwater Cleanup Level**	**Site-Specific Cleanup Level (µg/L)**	**Final Cleanup Level (µg/L)**	**Remediation Level (µg/L)**
Vinyl chloride	1.69	API Fisher MTCA Method B - 730-2 Modified Ingestion of Fish	0.0313	MTCA Method B - 720-2	11,600	USGS 1999	2.4	AWQC Federal Human Health Consumption of Organisms Only	0.02	0.0313	Method B Drinking Water	NA	0.0313	NA
Zinc	705	API Fisher MTCA Method B - 730-1 Modified Ingestion of Fish	480	MTCA Method B - 720-1	81	State AWQC	81	AWQC Federal Saltwater CCC	0.5	81	Ecological RA: State AWQC	NA	81	NA

Notes:

Revised since FS.

-- = No value was available
API Fisher = Asian Pacific Islander Fisherman
AQUIRE = U.S. EPA AQUIRE Database - available on-line at http://www.epa.gov/ecotox/
ARAR - Applicable of Relevant and Appropriate Requirements
AWQC = Federal Ambient Water Quality Criteria (Section 304 of the Clean Water Act)
CCC = Criteria Continuous Concentration
CMC = Criteria Maximum Concentration
CUL = Cleanup Level
GW - Groundwater
MTCA = Model Toxics Control Act (WAC 173-340)
NA = Not applicable.
ORNL = Oak Ridge Nation Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota - http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html and go to screening benchmark reports
PQL - Practical Quantification Limit
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State AWQC = WAC 173-201A - Water Quality Standards for Surface Waters of the State of Washington
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USGS 1999 = United States Geological Survey - Selection Procedure and Salient Information for Volatile Organic Compounds Emphasized in National Water Quality
WAC - Washington Administrative Code

TABLE 8

SOIL CLEANUP LEVELS

PSC Georgetown Facility
Seattle, Washington

Concentrations in milligrams per kilogram (mg/kg)

Constituent	Minimum Industrial Risk-Based Soil Cleanup Level[1]		GW Protection Cleanup Level[2]	Puget Sound Natural Background Levels	Applicable PQLs[4]	Final Soil Cleanup Level	
	(mg/kg)	Basis	(mg/kg)	(mg/kg)[3]	(mg/kg)	(mg/kg)	Basis
1,1,1-Trichloroethane	5.38E-01	Min. Method C Cleanup Level	7.95E-02	--[5]	5.00E-03	7.95E-02	Protection of Groundwater
1,1-Dichloroethane	1.44E-01	Min. Method C Cleanup Level	1.55E-01	--	5.00E-03	1.44E-01	Min. Method C Cleanup Level
1,1-Dichloroethene	1.75E-02	Min. Method C Cleanup Level	1.92E-01	--	5.00E-03	1.75E-02	Min. Method C Cleanup Level
1,2,4-Trichlorobenzene	9.02E+00	Min. Method C Cleanup Level	4.05E-01	--	5.00E-03	4.05E-01	Protection of Groundwater
1,2,4-Trimethylbenzene	1.47E-01	Min. Method C Cleanup Level	7.36E-01	--	5.00E-03	1.47E-01	Min. Method C Cleanup Level
1,2-Dichlorobenzene	1.33E+00	Min. Method C Cleanup Level	2.88E-01	--	5.00E-03	2.88E-01	Protection of Groundwater
1,2-Dichloroethane	1.18E-03	Min. Method C Cleanup Level	2.71E-02	--	5.00E-03	5.00E-03	PQL
1,3,5-Trimethylbenzene	2.45E-02	Min. Method C Cleanup Level	1.57E-01	--	5.00E-03	2.45E-02	Min. Method C Cleanup Level
2,4-Dimethylphenol	1.56E+03	Min. Method C Cleanup Level	1.53E-01	--	5.00E-02	1.53E-01	Protection of Groundwater
2-Hexanone	8.44E+03	Min. Method C Cleanup Level	1.26E-01	--	2.00E-02	1.26E-01	Protection of Groundwater
2-Methylnaphthalene	8.45E+02	Min. Method C Cleanup Level	3.60E-01	--	3.40E-03	3.60E-01	Protection of Groundwater
2-Methylphenol	3.89E+03	Min. Method C Cleanup Level	4.18E-02	--	1.00E-02	4.18E-02	Protection of Groundwater
4-Methylphenol	3.89E+02	Min. Method C Cleanup Level	2.30E-01	--	1.00E-02	2.30E-01	Protection of Groundwater
Acetone	7.00E+04	Min. Method C Cleanup Level	1.76E+00	--	5.00E-03	1.76E+00	Protection of Groundwater
Aroclor 1016/1242	1.46E+00	Min. Method C Cleanup Level	--	--	1.00E-02	1.46E+00	Min. Method C Cleanup Level
Aroclor 1254	1.46E+00	Min. Method C Cleanup Level	--	--	1.00E-02	1.46E+00	Min. Method C Cleanup Level
Aroclor 1260	1.46E+00	Min. Method C Cleanup Level	--	--	1.00E-02	1.46E+00	Min. Method C Cleanup Level
Arsenic	4.66E+00	Min. Method C Cleanup Level	6.84E-03	7.3	5.00E-01	7.30E+00	Puget Sound Background
Barium	1.24E+04	Min. Method C Cleanup Level	3.28E+00	--	5.00E-02	3.28E+00	Protection of Groundwater
Benzene	1.10E-03	Min. Method C Cleanup Level	3.36E-02	--	5.00E-03	5.00E-03	PQL
Benzo(a)anthracene	2.00E+00	Method A Ind. Cleanup Level	1.43E-01	--	1.60E-03	1.43E-01	Protection of Groundwater
Benzo(a)pyrene	2.57E-01	Min. Method C Cleanup Level	1.01E+01	--	2.20E-03	2.57E-01	Min. Method C Cleanup Level
Benzo(b)fluoranthene	2.00E+00	Method A Ind. Cleanup Level	4.66E-01	--	4.80E-03	4.66E-01	Protection of Groundwater
Benzo(ghi)perylene	--	--	---	--	2.30E-03	--	
Benzo(k)fluoranthene	2.00E+00	Method A Ind. Cleanup Level	4.32E-01	--	3.30E-03	4.32E-01	Protection of Groundwater
Benzoic acid	6.83E+05	Min. Method C Cleanup Level	4.89E-02	--	2.00E-01	2.00E-01	PQL
Bis(2-ethylhexyl) phthalate	2.08E+02	Min. Method C Cleanup Level	5.49E+01	--	1.70E-02	5.49E+01	Protection of Groundwater
Cadmium (food)	2.00E+00	Method A Ind. Cleanup Level	3.38E-02	1	5.00E-02	5.00E-02	PQL
Chloroethane	6.58E-01	Min. Method C Cleanup Level	1.67E+00	--	5.00E-03	6.58E-01	Min. Method C Cleanup Level

TABLE 8

SOIL CLEANUP LEVELS
PSC Georgetown Facility
Seattle, Washington

Concentrations in milligrams per kilogram (mg/kg)

Constituent	Minimum Industrial Risk-Based Soil Cleanup Level[1]		GW Protection Cleanup Level[2]	Puget Sound Natural Background Levels	Applicable PQLs[4]	Final Soil Cleanup Level	
	(mg/kg)	Basis	(mg/kg)	(mg/kg)[3]	(mg/kg)	(mg/kg)	Basis
Chloroform	4.70E-04	Min. Method C Cleanup Level	1.20E-02	--	5.00E-03	5.00E-03	PQL
Chromium	2.00E+03	Method A Ind. Cleanup Level	2.00E+02	48.2	2.00E-01	2.00E+02	Protection of Groundwater
Chrysene	2.00E+00	Method A Ind. Cleanup Level	1.44E-01	--	4.10E-03	1.44E-01	Protection of Groundwater
cis-1,2-Dichloroethene	9.93E-03	Min. Method C Cleanup Level	1.95E-01	--	5.00E-03	9.93E-03	Min. Method C Cleanup Level
cis-1,3-Dichloropropene	--	--	2.84E-04	--	5.00E-03	5.00E-03	PQL
Copper	6.91E+03	Min. Method C Cleanup Level	1.37E+00	36.4	1.00E-01	3.64E+01	Puget Sound Background
Cumene	1.52E-02	Min. Method C Cleanup Level	4.99E+01	--	5.00E-03	1.52E-02	Min. Method C Cleanup Level
Cyanide	3.73E+03	Min. Method C Cleanup Level	1.18E-02	--	1.00E-01	1.00E-01	PQL
Dibenzo(a,h)anthracene	6.42E-01	Min. Method C Cleanup Level	2.39E+00	--	2.60E-03	6.42E-01	Min. Method C Cleanup Level
Dibenzofuran	8.45E+02	Min. Method C Cleanup Level	2.91E-01	--	1.70E-03	2.91E-01	Protection of Groundwater
Diesel range hydrocarbons	2.00E+03	Method A Cleanup Level	--	--	2.50E+01	2.00E+03	Method A Cleanup Level
Di-n-butyl phthalate	7.78E+03	Min. Method C Cleanup Level	1.14E+00	--	1.00E-02	1.14E+00	Protection of Groundwater
di-n-octyl-phthalate	1.56E+03	Min. Method C Cleanup Level	6.92E+04	--	1.00E-02	1.56E+03	Min. Method C Cleanup Level
Ethylbenzene	8.02E-01	Min. Method C Cleanup Level	8.52E+00	--	5.00E-03	8.02E-01	Min. Method C Cleanup Level
Fluoranthene	3.11E+03	Min. Method C Cleanup Level	4.57E+00	--	3.40E-03	4.57E+00	Protection of Groundwater
Gasoline range hydrocarbons	3.00E+01	Method A Cleanup Level	--	--	5.00E+00	3.00E+01	Method A Cleanup Level
Indeno(1,2,3-cd)pyrene	2.00E+00	Method A Ind. Cleanup Level	4.31E+00	--	2.40E-03	2.00E+00	Min. Method C Cleanup Level
Lead	1.00E+03	Method A Ind. Cleanup Level	5.00E+02	16.8	5.00E-02	5.00E+02	Protection of Groundwater
Lube oil range hydrocarbons	2.00E+03	Method A Cleanup Level	--	--	2.50E+01	2.00E+03	Method A Cleanup Level
Mercury	2.00E+00	Method A Ind. Cleanup Level	1.25E-02	0.07	2.00E-02	7.00E-02	Puget Sound Background
Methyl isobutyl ketone (MIBK)	8.50E+01	Min. Method C Cleanup Level	2.65E-01	--	5.00E-03	2.65E-01	Protection of Groundwater
Methylene chloride	1.05E-02	Min. Method C Cleanup Level	5.71E-01	--	5.00E-03	1.05E-02	Min. Method C Cleanup Level
Mineral spirits	1.00E+02	Method A, TPH-G[6] (no benzene)	--	--	9.00E+00	1.00E+02	Method A, TPH-G6 (no benzene)
Naphthalene	2.64E-01	Min. Method C Cleanup Level	1.48E+00	--	5.00E-03	2.64E-01	Min. Method C Cleanup Level
n-Butylbenzene	1.52E-01	Min. Method C Cleanup Level	2.49E-01	--	5.00E-03	1.52E-01	Min. Method C Cleanup Level
Nickel	3.73E+03	Min. Method C Cleanup Level	1.07E+01	38.2	2.00E-01	3.82E+01	Puget Sound Background
Pentachlorophenol	2.43E+01	Min. Method C Cleanup Level	3.29E-02	--	1.50E-01	1.50E-01	PQL
Phenanthrene	--	--	4.86E-01	--	3.30E-03	4.86E-01	Protection of Groundwater
Phenol	2.33E+04	Min. Method C Cleanup Level	2.04E-01	--	1.90E-02	2.04E-01	Protection of Groundwater

TABLE 8

SOIL CLEANUP LEVELS

PSC Georgetown Facility
Seattle, Washington

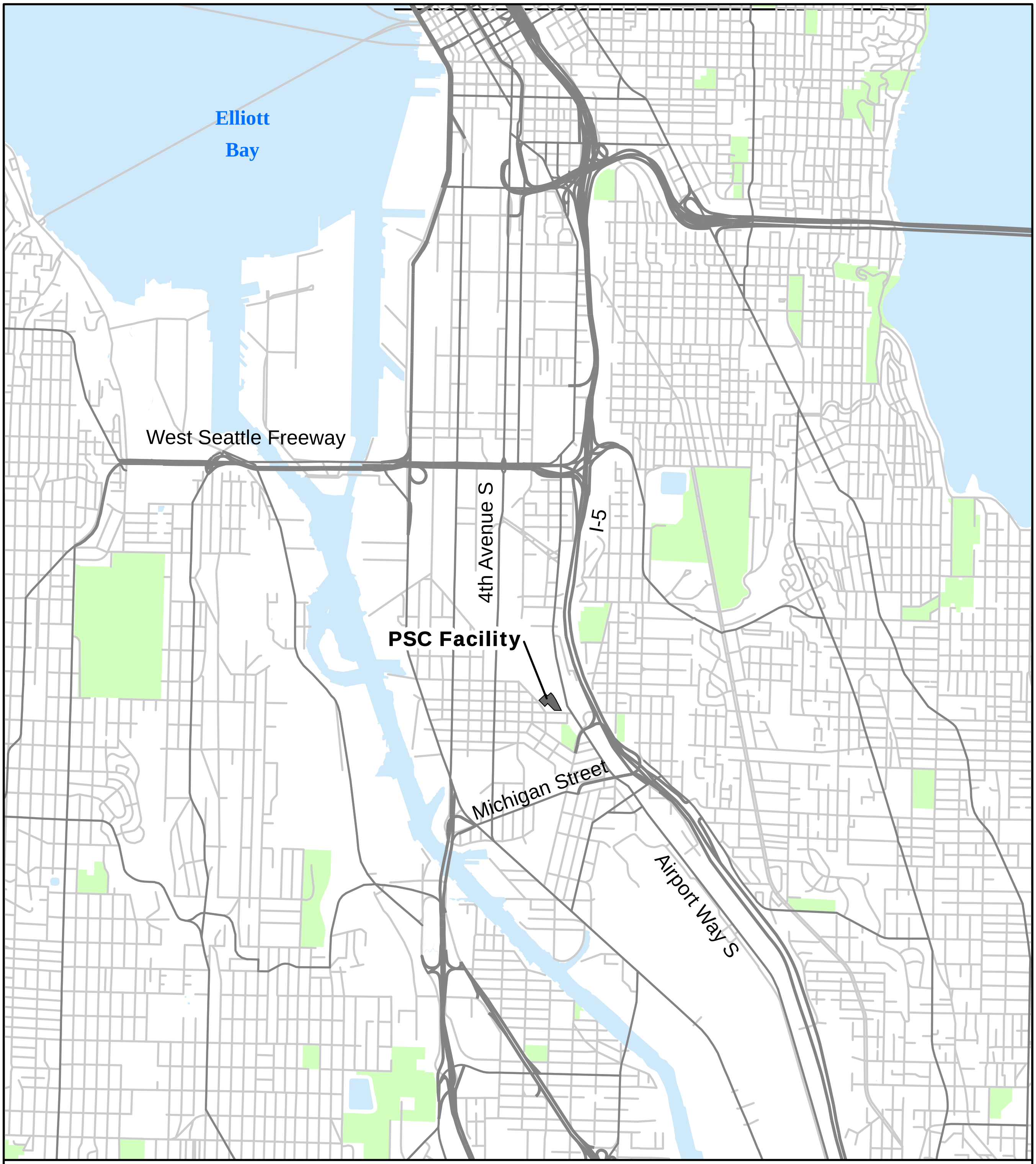
Concentrations in milligrams per kilogram (mg/kg)

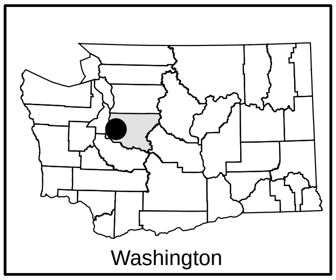
Constituent	Minimum Industrial Risk-Based Soil Cleanup Level[1]		GW Protection Cleanup Level[2]	Puget Sound Natural Background Levels	Applicable PQLs[4]	Final Soil Cleanup Level	
	(mg/kg)	Basis	(mg/kg)	(mg/kg)[3]	(mg/kg)	(mg/kg)	Basis
p-Isopropyltoluene	1.85E+08	Min. Method C Cleanup Level	2.49E-01	--	5.00E-03	2.49E-01	Protection of Groundwater
Propylbenzene	2.25E-01	Min. Method C Cleanup Level	4.85E-01	--	5.00E-03	2.25E-01	Min. Method C Cleanup Level
Pyrene	2.33E+03	Min. Method C Cleanup Level	1.82E+02	--	3.60E-03	1.82E+02	Protection of Groundwater
sec-Butylbenzene	1.52E-01	Min. Method C Cleanup Level	4.61E-02	--	5.00E-03	4.61E-02	Protection of Groundwater
Selenium	1.75E+03	Min. Method C Cleanup Level	5.06E-01	--	1.00E-01	5.06E-01	Min. Method C Cleanup Level
Silver	9.33E+02	Min. Method C Cleanup Level	3.18E-01	--	2.00E-02	3.18E-01	Protection of Groundwater
Stoddard solvent	1.00E+02	Method A, TPH-G (no benzene)	--	--	9.00E+00	--	Method A, TPH-G (no benzene)
Styrene	8.64E+00	Min. Method C Cleanup Level	2.99E-01	--	5.00E-03	2.99E-01	Protection of Groundwater
Tetrachloroethene	1.90E-03	Min. Method C Cleanup Level	2.02E-03	--	3.10E-03	3.10E-03	PQL
Toluene	2.56E-01	Min. Method C Cleanup Level	2.60E+00	--	5.00E-03	2.56E-01	Min. Method C Cleanup Level
trans-1,2-Dichloroethene	9.69E-03	Min. Method C Cleanup Level	2.46E-01	--	5.00E-03	9.69E-03	Min. Method C Cleanup Level
trans-1,3-Dichloropropene	--	--	1.02E-04	--	5.00E-03	5.00E-03	PQL
Trichloroethene	6.24E-05	Min. Method C Cleanup Level	2.80E-04	--	2.80E-03	2.80E-03	PQL
Trichlorofluoromethane	8.61E+04	Min. Method C Cleanup Level			5.00E-03	1.70E+00	Protection of Groundwater
Vinyl chloride	1.20E-04	Min. Method C Cleanup Level	8.66E-03	--	5.00E-03	5.00E-03	PQL
Xylenes (Total)	1.80E-01	Min. Method C Cleanup Level	1.02E+00	--	5.00E-03	1.80E-01	Min. Method C Cleanup Level
Zinc	5.60E+04	Min. Method C Cleanup Level	1.01E+02	85.1	5.00E-01	1.01E+02	Protection of Groundwater

Notes:

1. Minimum industrial soil cleanup level calculated using cumulative constituent cancer risk goal = 1E-06 and hazard quotient = 0.1 and compared to Model Toxics Control Act Method A Soil Cleanup
2. Soil-to-groundwater cleanup level based on Site-Wide Feasibility Study groundwater cleanup level.
3. Puget Sound Background Levels from Natural Background Soil Metals Concentrations in Washington State, Toxics Cleanup Program, Washington State Department of Ecology, Publication # 94-115, October 1994.
4. PQL = Practical Quantitation Limit; PQL for constituents other than mineral spirits and stoddard solvent were established per WAC 173-340-707. The PQLs for mineral spirits and stoddard solvent were not available from CAS; the values cited are the lowest reported reporting limits obtained from laboratory reports received for the off-site investigation.
5. -- = No value was available.
6. TPH-G = Total petroleum hydrocarbons, gasoline range.

FIGURES





0 2,000 4,000
Feet

N

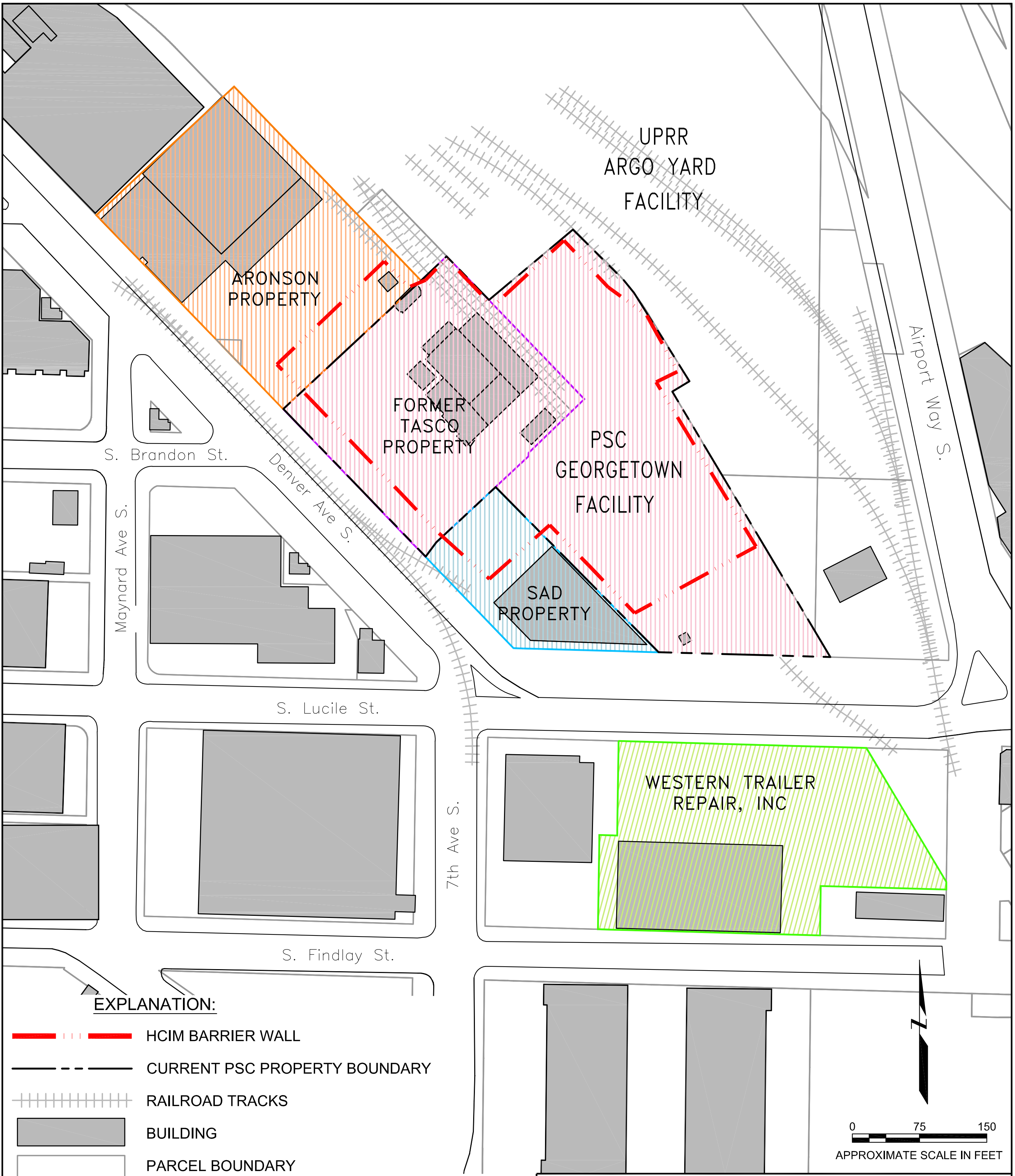
LOCATION MAP
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 11/04/08	Project No. 8770

AMEC Geomatrix

Figure 1

S:\8770_2006\025_CAP-RevisedNov08\GIS\SiteLocation.mxd



EXPLANATION:

- ▬ HCIM BARRIER WALL
- ▬ CURRENT PSC PROPERTY BOUNDARY
- ┼┼┼ RAILROAD TRACKS
- ■ BUILDING
- □ PARCEL BOUNDARY
- ▨ FORMER TASCO PROPERTY (NOW OWNED BY PSC)
- ▨ STONE-DREW / ASHE & JONES, INC. (SAD) PROPERTY
- ▨ ARONSON PROPERTY
- ▨ WESTERN TRAILER REPAIR, INC.

PSC PROPERTY AND SITE VICINITY
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 2

Plot Date: 01/15/09 - 6:35am, Plotted by: adam.stenberg
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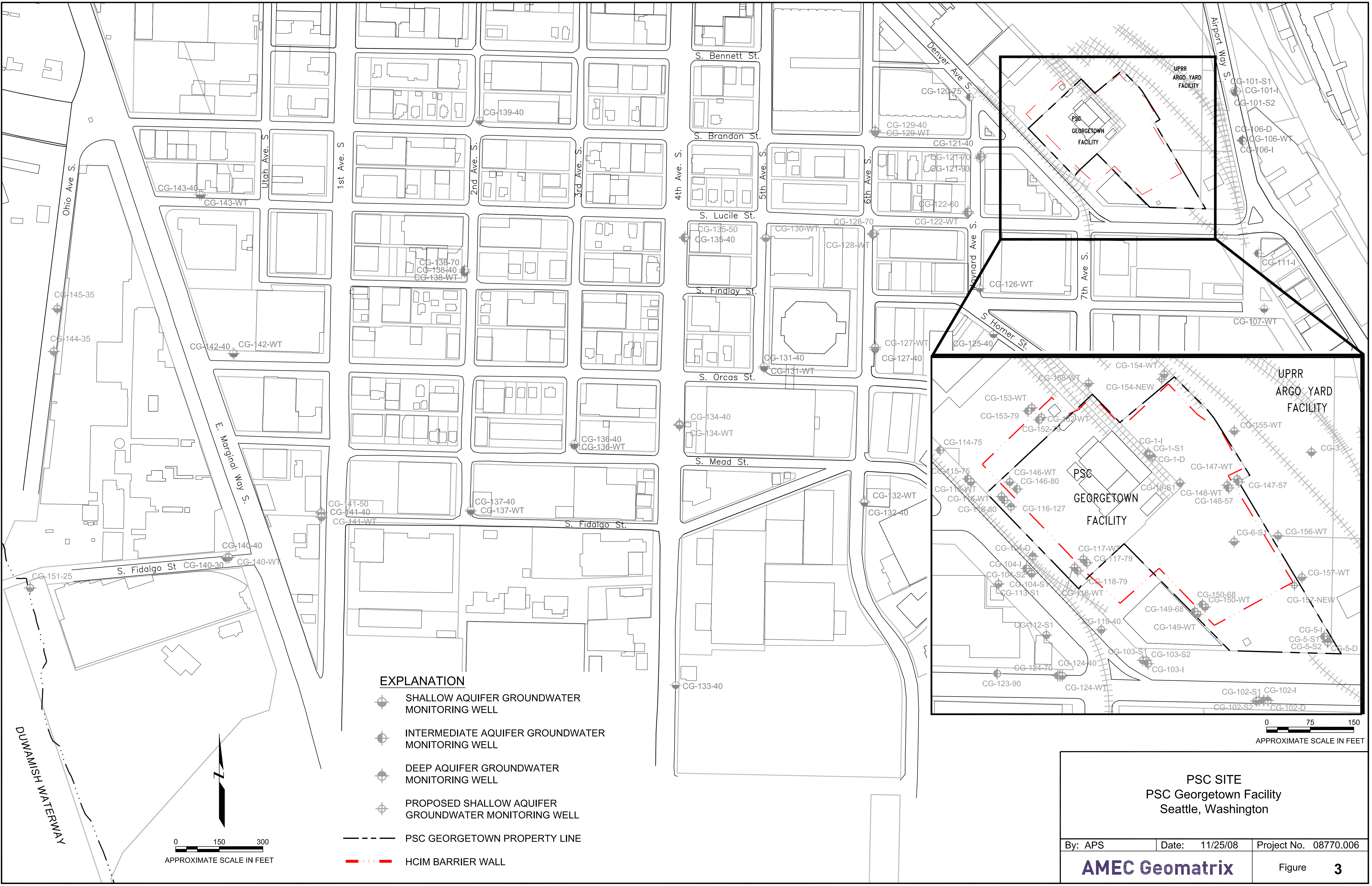

PSC SITE
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 11/25/08	Project No. 08770.006
AMEC Geomatrix		Figure 3

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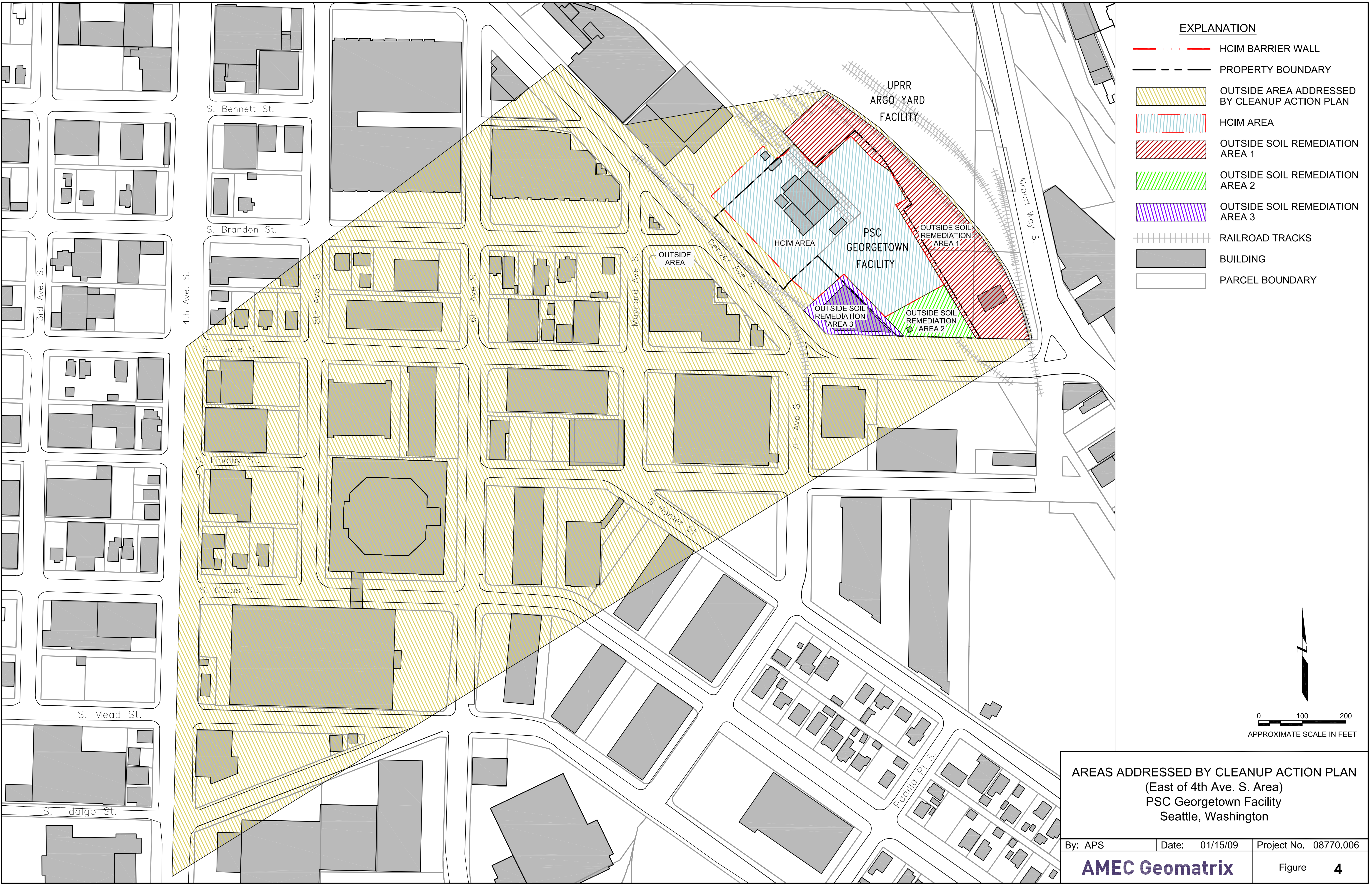

AREAS ADDRESSED BY CLEANUP ACTION PLAN
(East of 4th Ave. S. Area)
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 4

Plot Date: 01/15/09 - 6:49am, Plotted by: adam.stenberg
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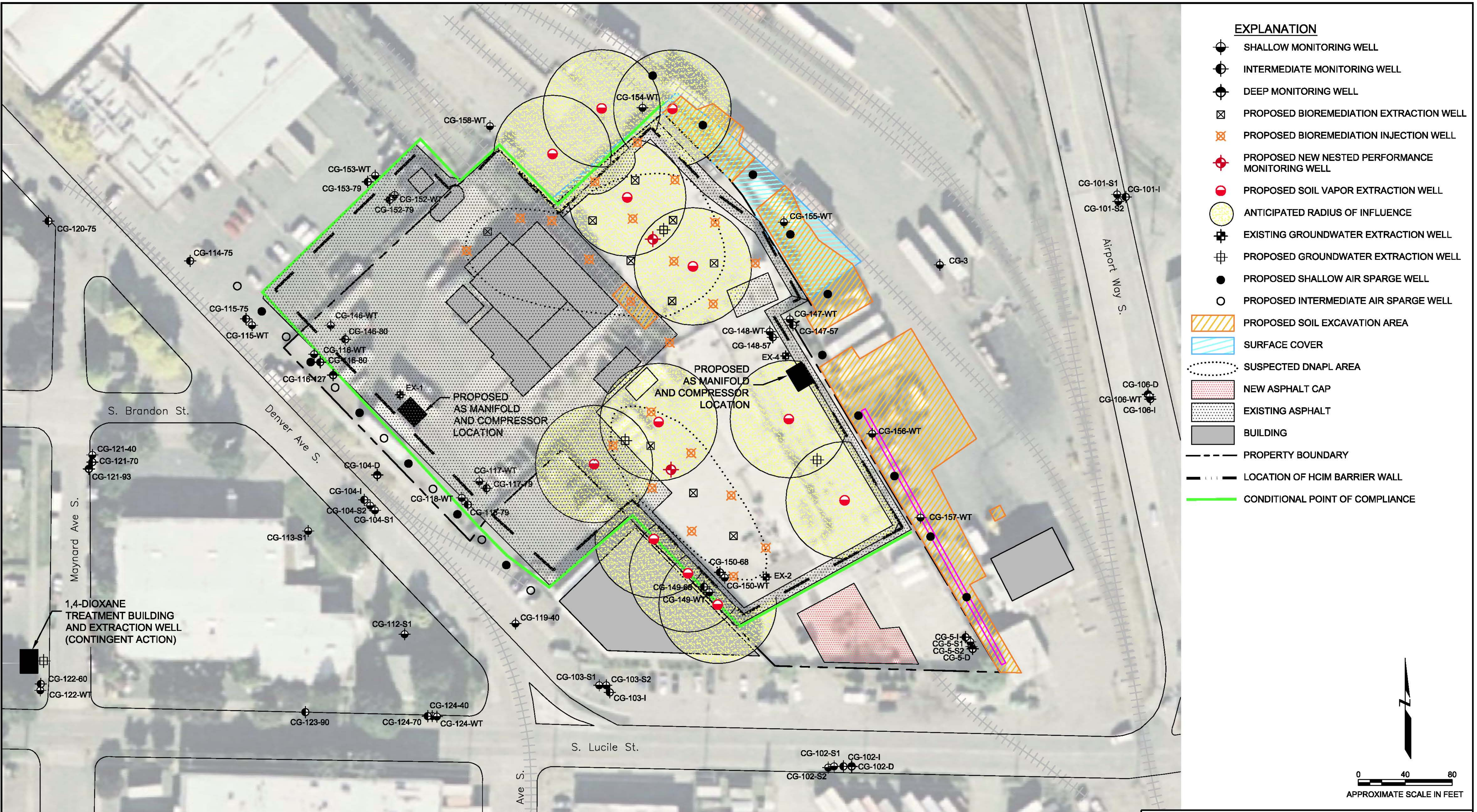

PROPOSED CLEANUP ACTION
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 5

Plot Date: 01/15/09 - 7:08am, Plotted by: adam.stenberg
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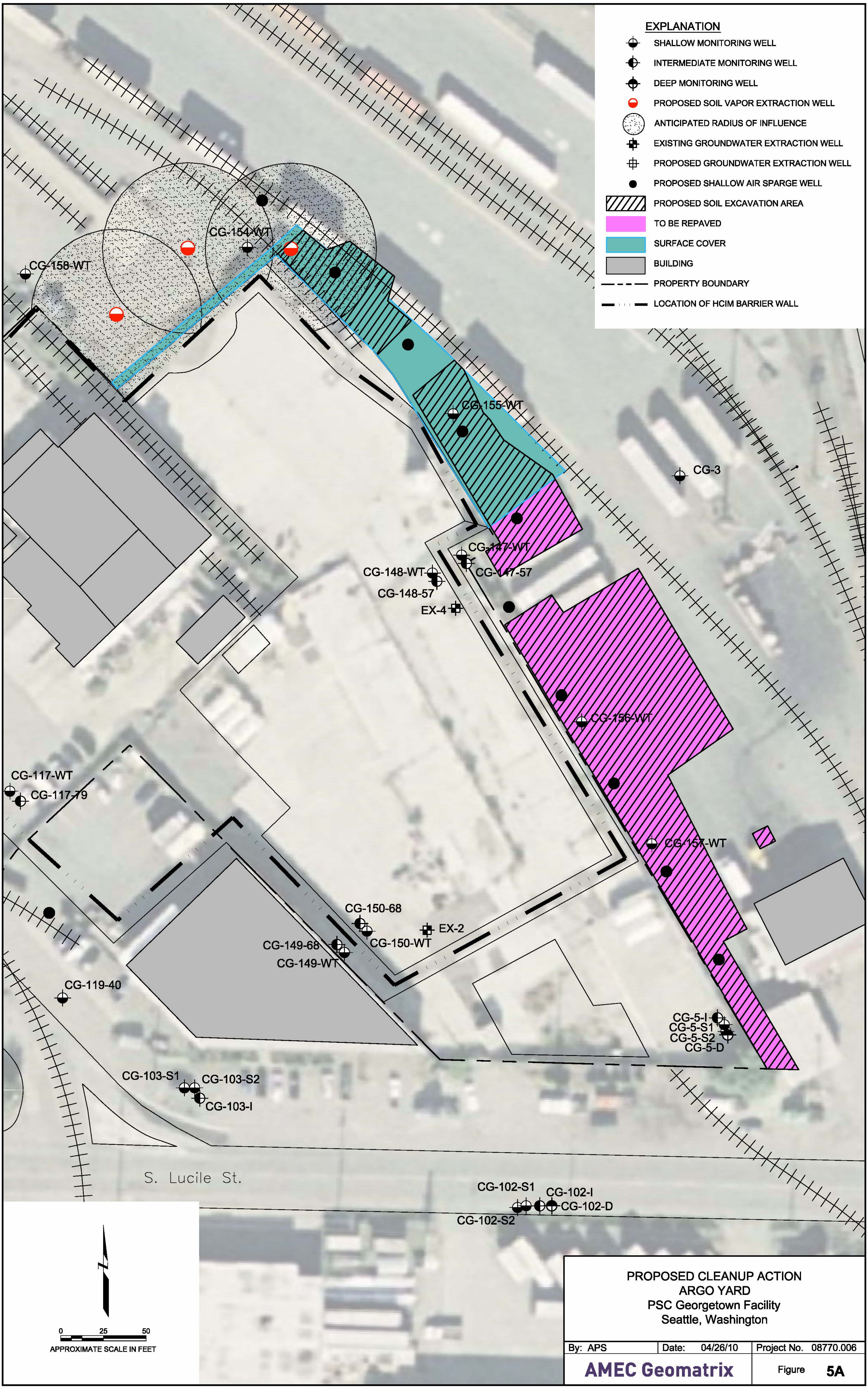

PROPOSED CLEANUP ACTION
ARGO YARD
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 04/26/10	Project No. 08770.006
AMEC Geomatrix		Figure 5A

Plot Date: 04/26/10 - 3:37pm, Plotted by: adam.stenberg
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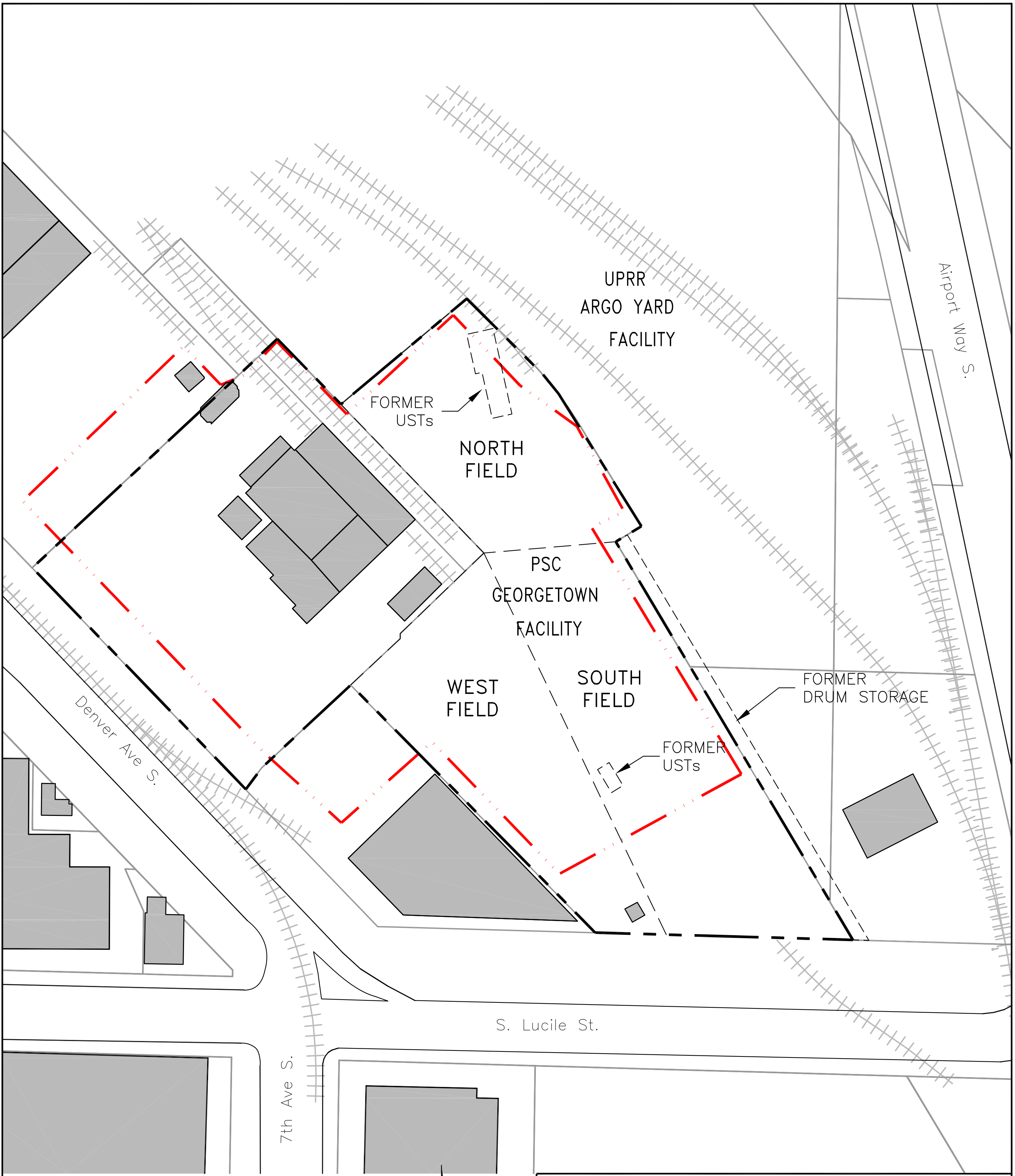

EXPLANATION

🟥 HCIM BARRIER WALL

━ PROPERTY BOUNDARY

┼ RAILROAD TRACKS

▨ EXISTING BUILDING

☐ PARCEL BOUNDARY

0 50 100

APPROXIMATE SCALE IN FEET

HISTORICAL FEATURES AT
734 SOUTH LUCILE STREET PROPERTY
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 6

Plot Date: 01/15/09 - 6:47am, Plotted by: adam.stenberg
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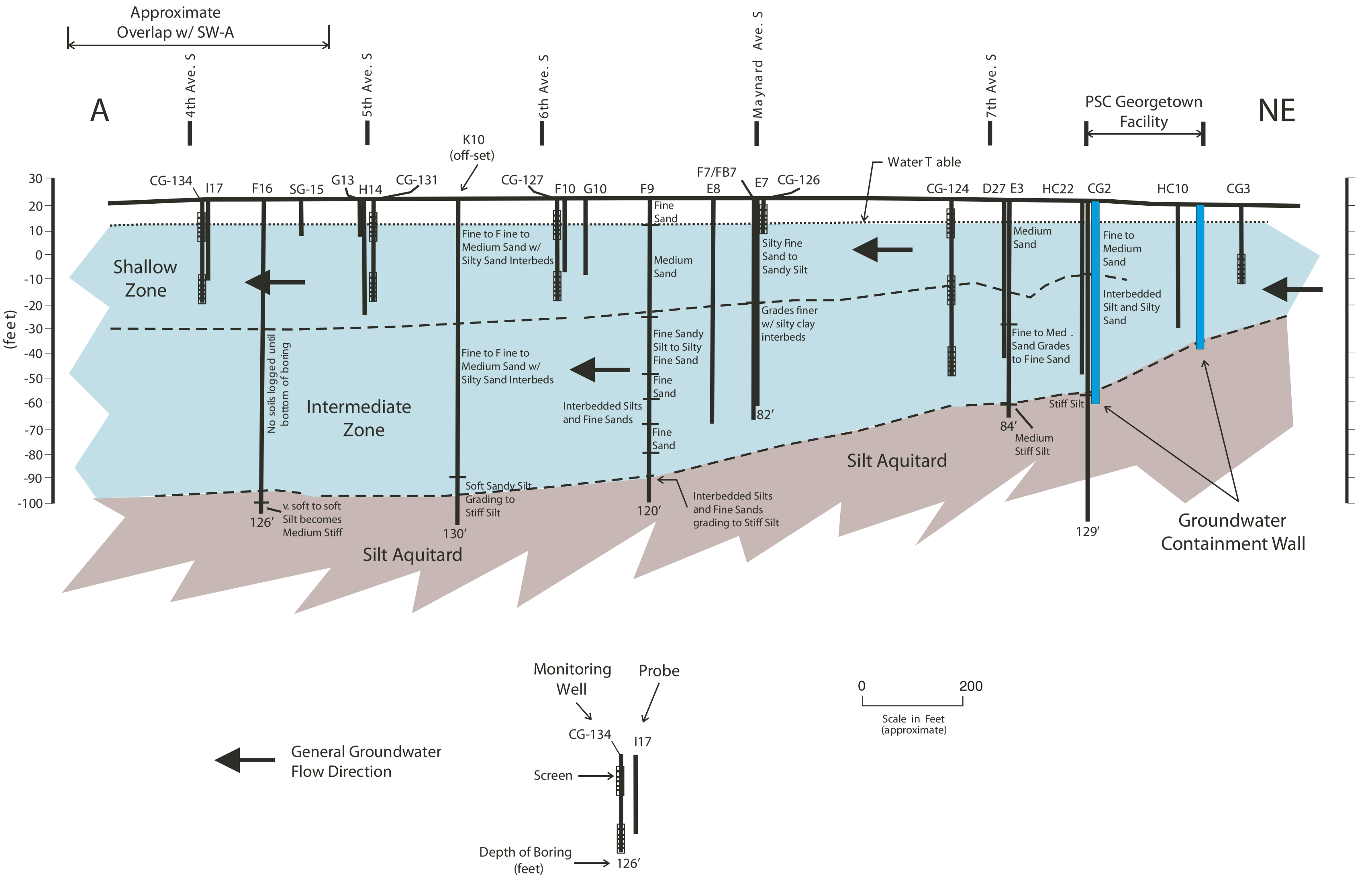
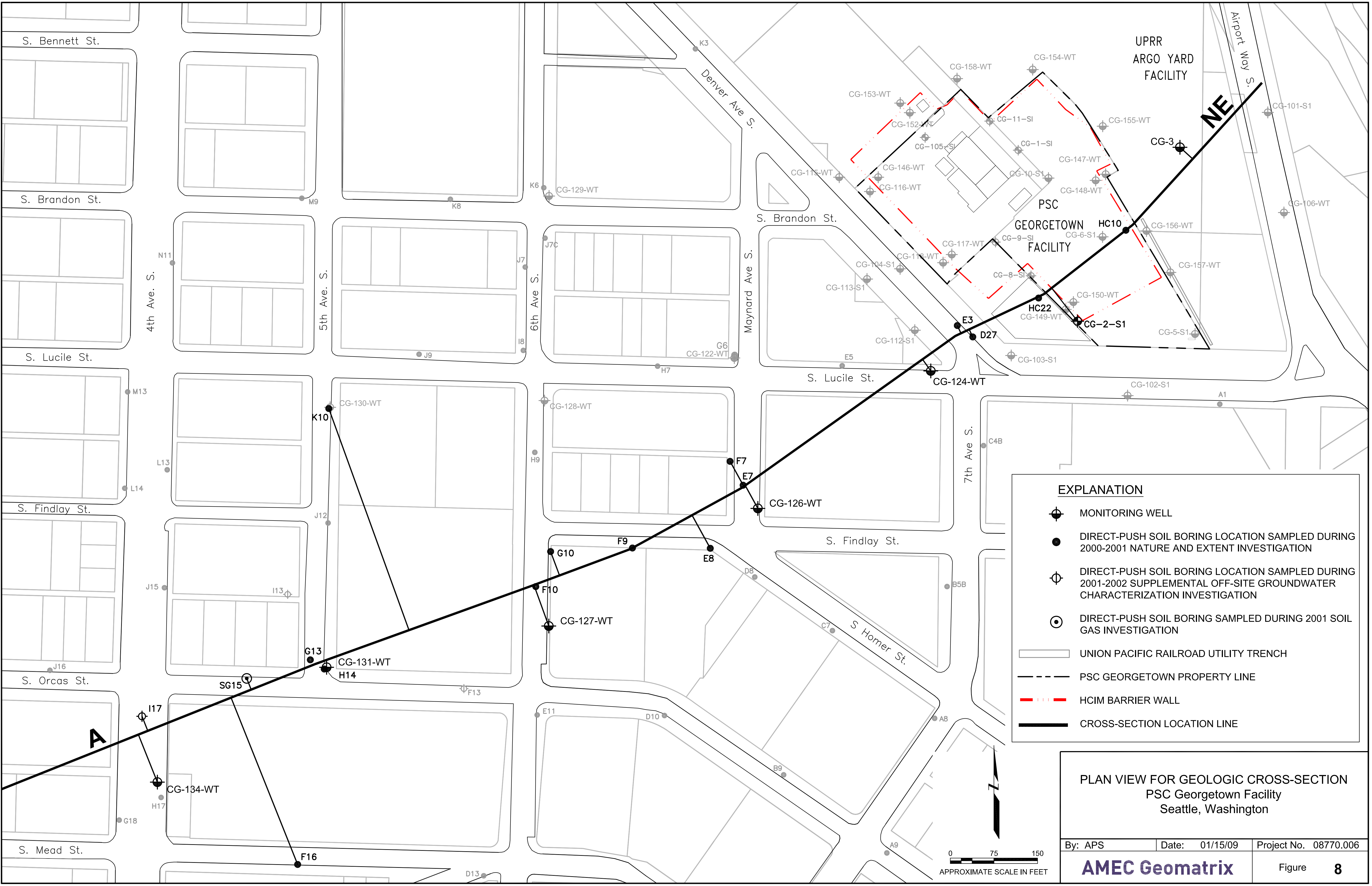


Note: This figure is adapted from *Report on Solvent Sources Downgradient of PSC-Georgetown Facility,* March 2005: Dalton, Olmsted & Fuglevand, Inc.

AMEC Geomatrix

GEOLOGIC CROSS-SECTION
PSC Georgetown Facility
Seattle, Washington

Project No.
8770
Figure
7



EXPLANATION

- ⌖ MONITORING WELL
- ● DIRECT-PUSH SOIL BORING LOCATION SAMPLED DURING 2000-2001 NATURE AND EXTENT INVESTIGATION
- ⦶ DIRECT-PUSH SOIL BORING LOCATION SAMPLED DURING 2001-2002 SUPPLEMENTAL OFF-SITE GROUNDWATER CHARACTERIZATION INVESTIGATION
- ⊙ DIRECT-PUSH SOIL BORING SAMPLED DURING 2001 SOIL GAS INVESTIGATION
- ▭ UNION PACIFIC RAILROAD UTILITY TRENCH
- — - — PSC GEORGETOWN PROPERTY LINE
- — · · — HCIM BARRIER WALL
- ━ CROSS-SECTION LOCATION LINE

PLAN VIEW FOR GEOLOGIC CROSS-SECTION
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix | Figure 8

Plot Date: 01/15/09 - 6:53am, Plotted by: adam.stenberg
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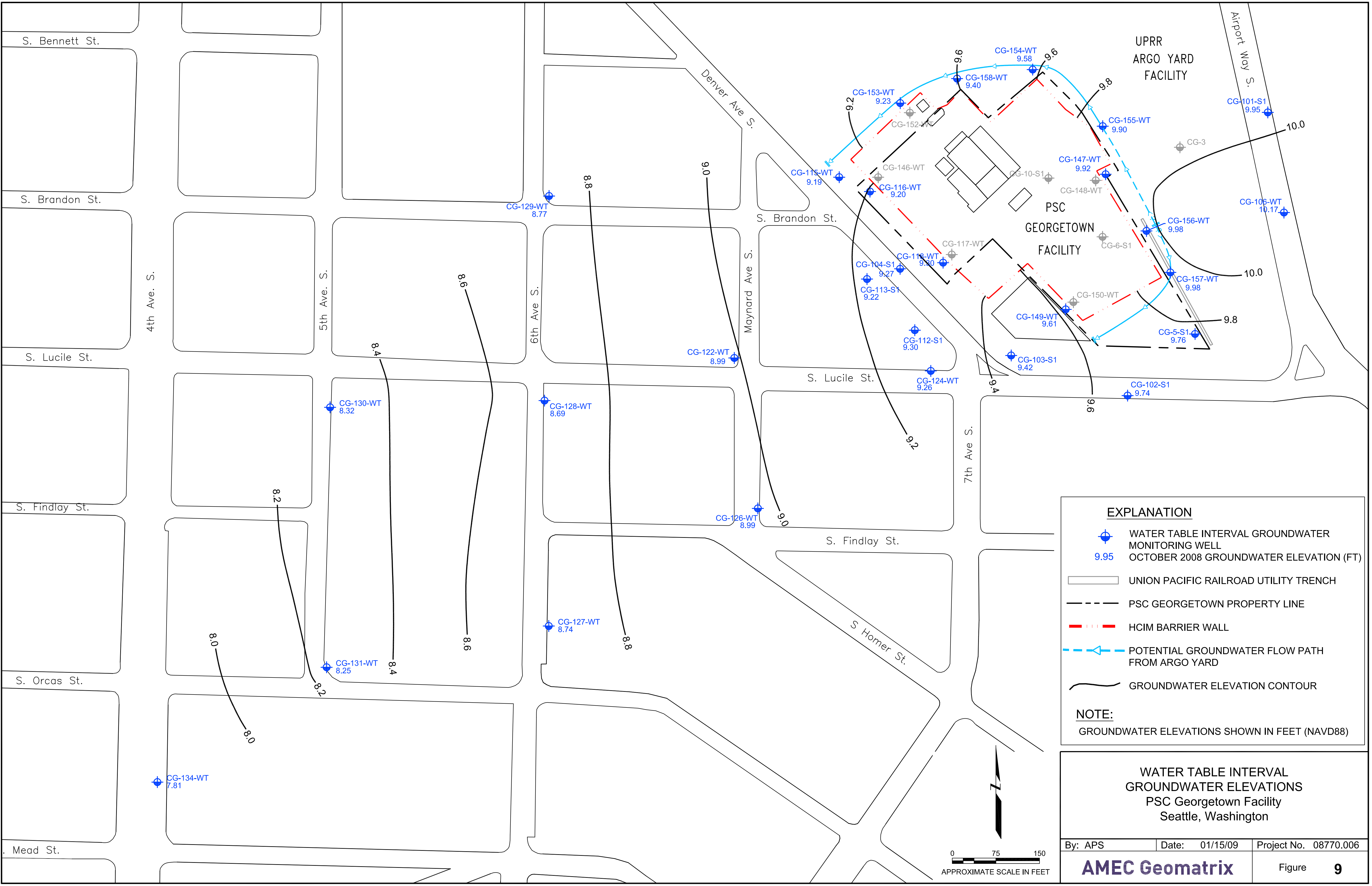

EXPLANATION

⌖ 9.95	WATER TABLE INTERVAL GROUNDWATER MONITORING WELL OCTOBER 2008 GROUNDWATER ELEVATION (FT)
▭	UNION PACIFIC RAILROAD UTILITY TRENCH
— · —	PSC GEORGETOWN PROPERTY LINE
— · —	HCIM BARRIER WALL
- - ◁ - -	POTENTIAL GROUNDWATER FLOW PATH FROM ARGO YARD
～	GROUNDWATER ELEVATION CONTOUR

NOTE:
GROUNDWATER ELEVATIONS SHOWN IN FEET (NAVD88)

WATER TABLE INTERVAL
GROUNDWATER ELEVATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix | Figure 9

Plot Date: 01/15/09 - 6:58am, Plotted by: adam.stenberg
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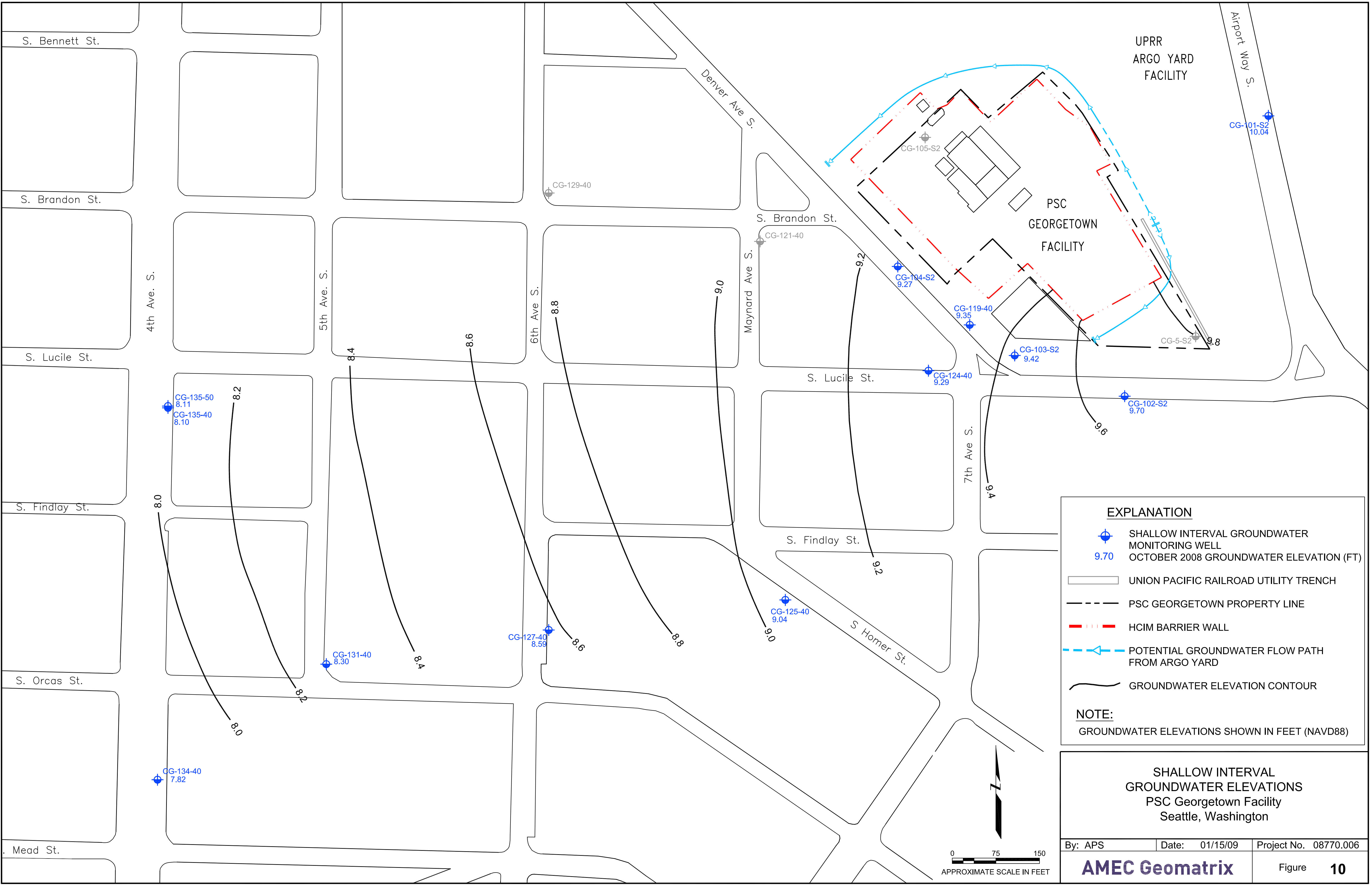

SHALLOW INTERVAL
GROUNDWATER ELEVATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 10

Plot Date: 01/15/09 - 6:59am, Plotted by: adam.stenberg
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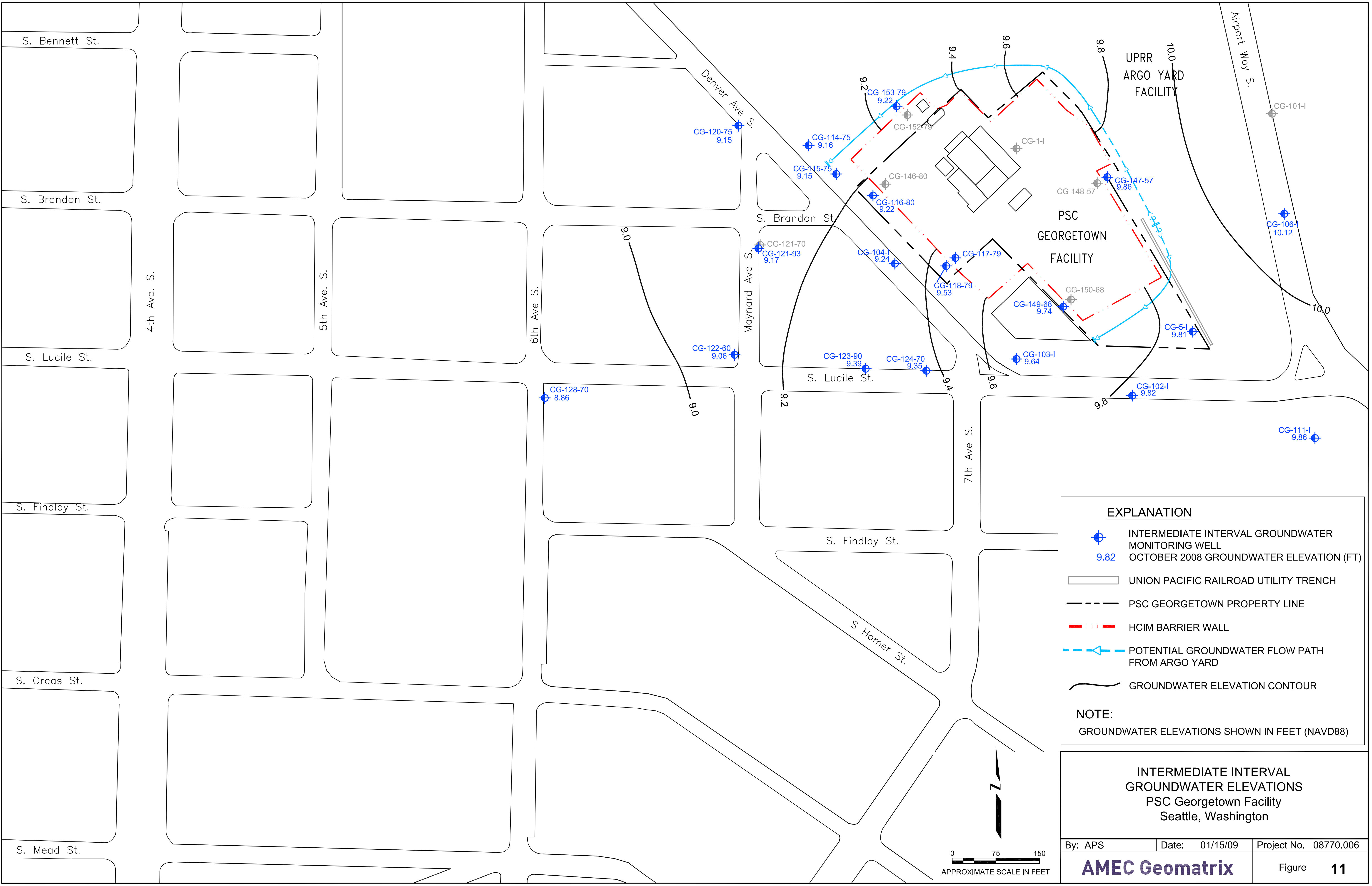


EXPLANATION

⊕ 9.82	INTERMEDIATE INTERVAL GROUNDWATER MONITORING WELL OCTOBER 2008 GROUNDWATER ELEVATION (FT)
▭	UNION PACIFIC RAILROAD UTILITY TRENCH
— - - —	PSC GEORGETOWN PROPERTY LINE
— · · —	HCIM BARRIER WALL
- - ◁ - -	POTENTIAL GROUNDWATER FLOW PATH FROM ARGO YARD
～	GROUNDWATER ELEVATION CONTOUR

NOTE:

GROUNDWATER ELEVATIONS SHOWN IN FEET (NAVD88)

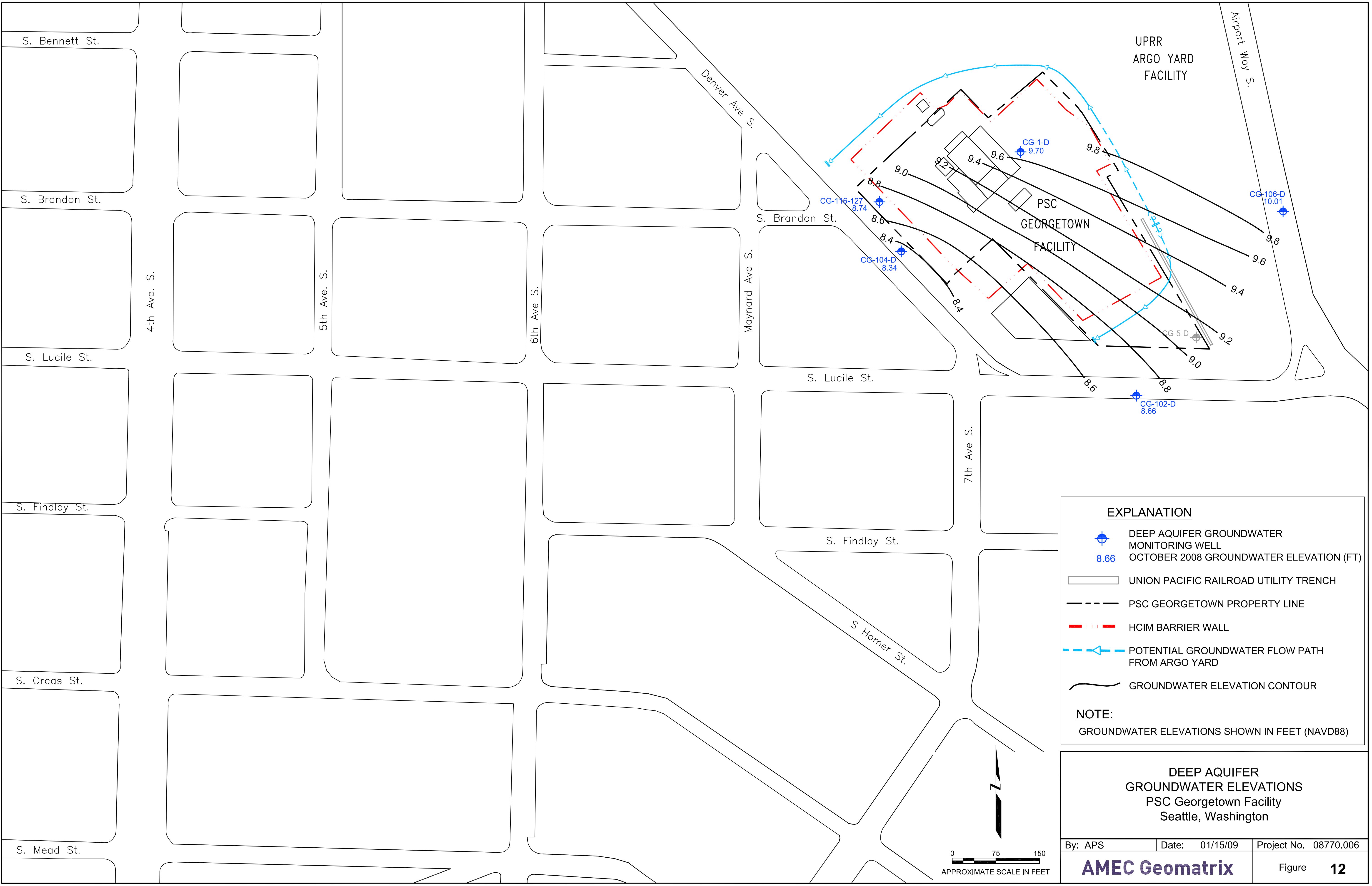
INTERMEDIATE INTERVAL
GROUNDWATER ELEVATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS
Date: 01/15/09
Project No. 08770.006

AMEC Geomatrix

Figure 11

Plot Date: 01/15/09 - 7:04am, Plotted by: adam.stenberg
Drawing Path: S:\8770_2006\025_CAP-RevisedNov08\CAD\, Drawing Name: PSC-GT_GW-Elev-INT_110408.dwg



EXPLANATION

⊕ 8.66 DEEP AQUIFER GROUNDWATER MONITORING WELL
OCTOBER 2008 GROUNDWATER ELEVATION (FT)

▭ UNION PACIFIC RAILROAD UTILITY TRENCH

PSC GEORGETOWN PROPERTY LINE

HCIM BARRIER WALL

POTENTIAL GROUNDWATER FLOW PATH FROM ARGO YARD

GROUNDWATER ELEVATION CONTOUR

NOTE:
GROUNDWATER ELEVATIONS SHOWN IN FEET (NAVD88)

DEEP AQUIFER GROUNDWATER ELEVATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS
Date: 01/15/09
Project No. 08770.006

AMEC Geomatrix

Figure 12

Plot Date: 01/15/09 - 7:06am, Plotted by: adam.stenberg
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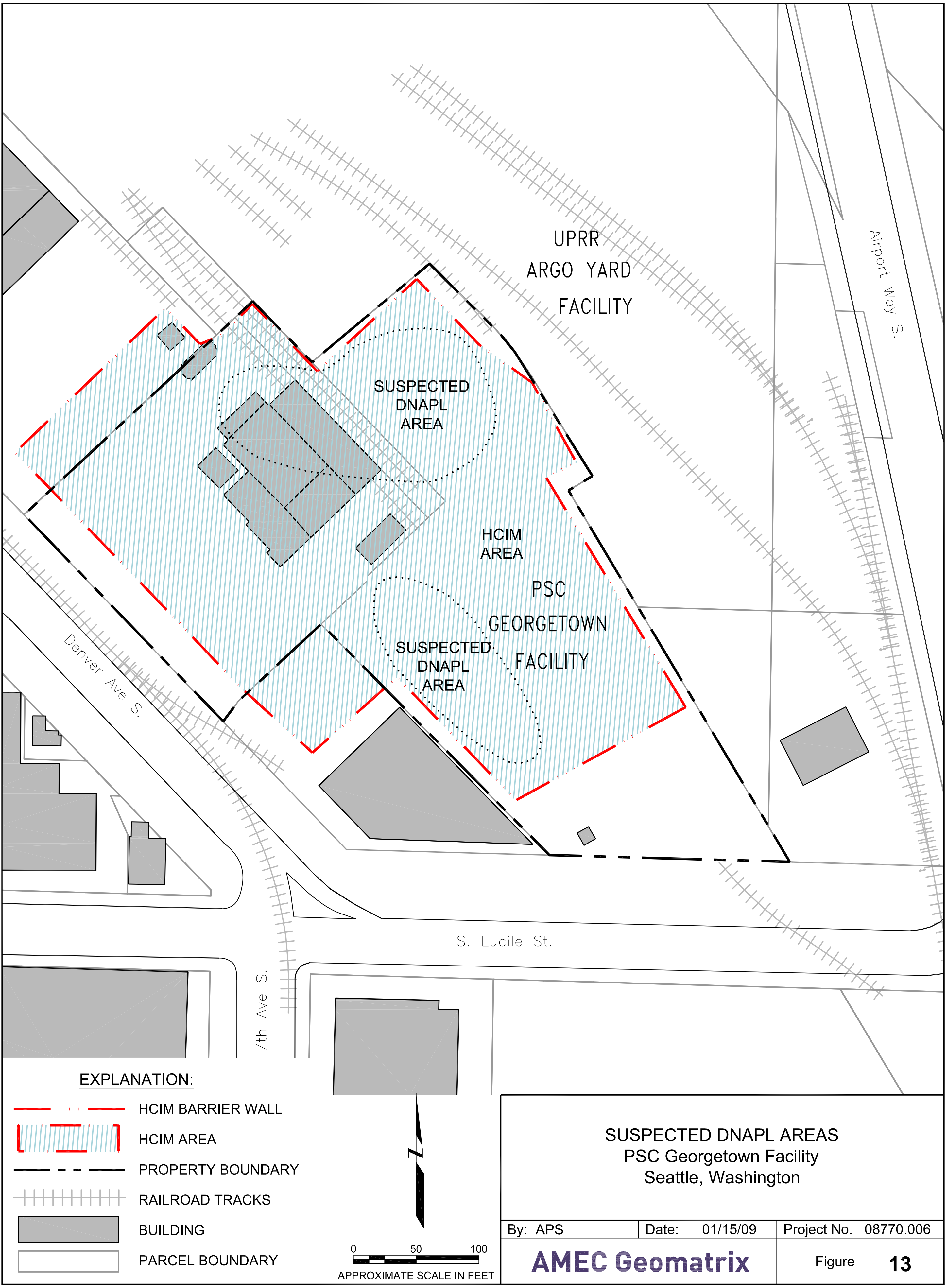

SUSPECTED DNAPL AREAS
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 13

Plot Date: 01/15/09 - 7:10am, Plotted by: adam.stenberg
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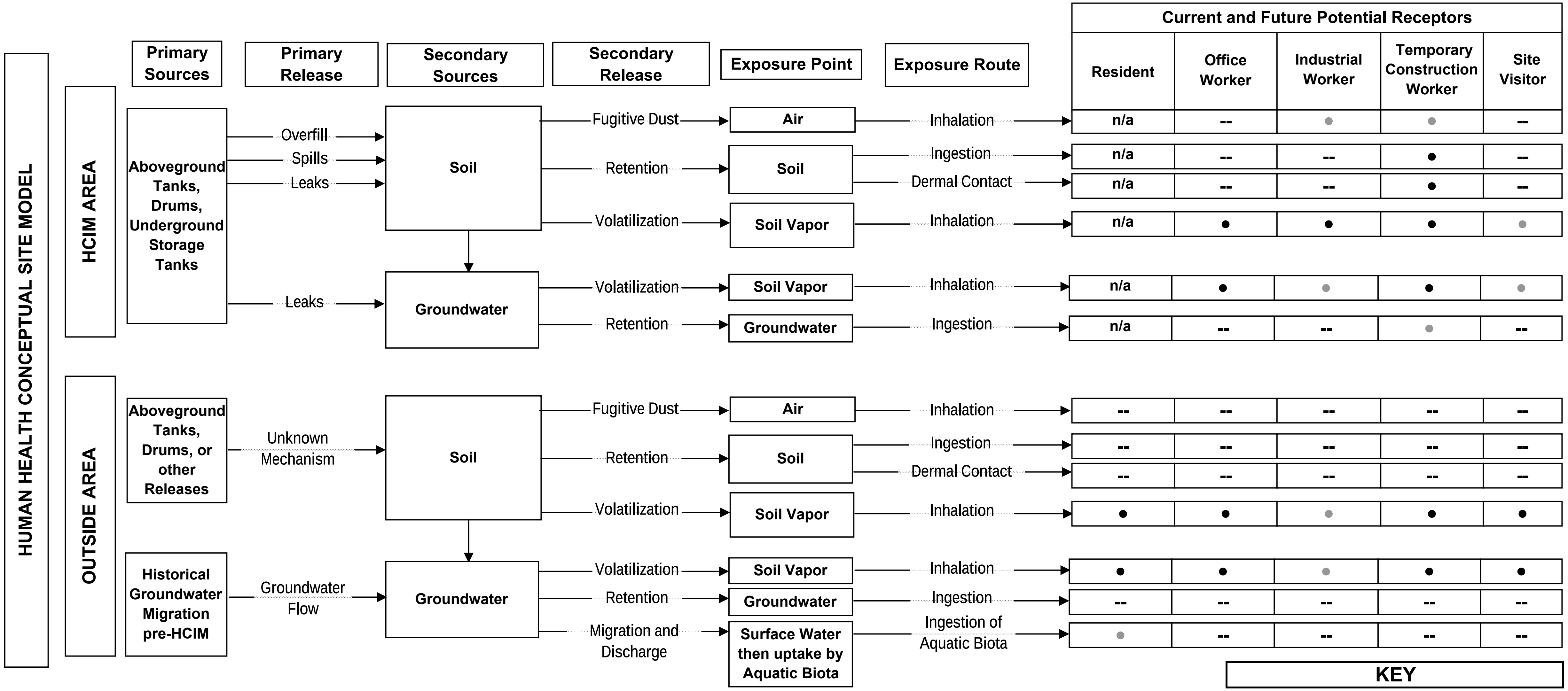
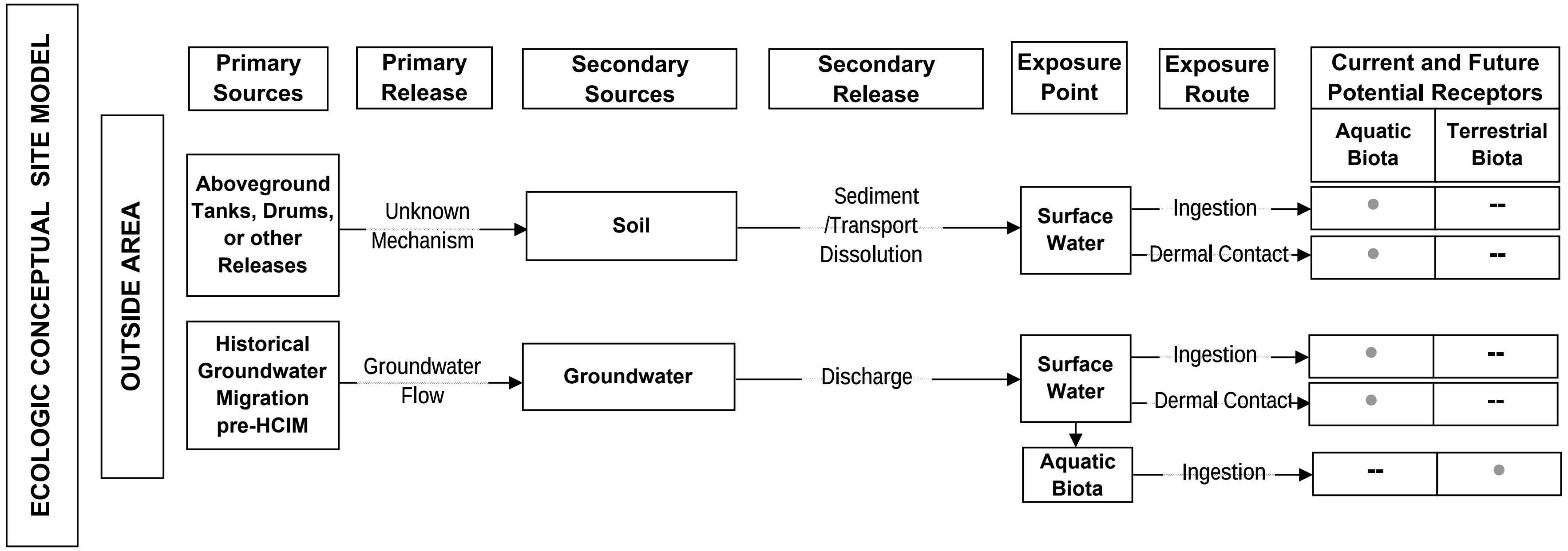


	Primary Sources	Primary Release	Secondary Sources	Secondary Release	Exposure Point	Exposure Route	Resident	Office Worker	Industrial Worker	Temporary Construction Worker	Site Visitor
HCIM AREA	Aboveground Tanks, Drums, Underground Storage Tanks	Overfill Spills Leaks	Soil	Fugitive Dust	Air	Inhalation	n/a	--	○	○	--
				Retention	Soil	Ingestion	n/a	--	--	●	--
						Dermal Contact	n/a	--	--	●	--
				Volatilization	Soil Vapor	Inhalation	n/a	●	●	●	○
		Leaks	Groundwater	Volatilization	Soil Vapor	Inhalation	n/a	●	○	●	○
				Retention	Groundwater	Ingestion	n/a	--	--	○	--
OUTSIDE AREA	Aboveground Tanks, Drums, or other Releases	Unknown Mechanism	Soil	Fugitive Dust	Air	Inhalation	--	--	--	--	--
				Retention	Soil	Ingestion	--	--	--	--	--
						Dermal Contact	--	--	--	--	--
				Volatilization	Soil Vapor	Inhalation	●	●	○	●	●
	Historical Groundwater Migration pre-HCIM	Groundwater Flow	Groundwater	Volatilization	Soil Vapor	Inhalation	●	●	○	●	●
				Retention	Groundwater	Ingestion	--	--	--	--	--
				Migration and Discharge	Surface Water then uptake by Aquatic Biota	Ingestion of Aquatic Biota	○	--	--	--	--

Current and Future Potential Receptors



	Primary Sources	Primary Release	Secondary Sources	Secondary Release	Exposure Point	Exposure Route	Aquatic Biota	Terrestrial Biota
OUTSIDE AREA	Aboveground Tanks, Drums, or other Releases	Unknown Mechanism	Soil	Sediment /Transport Dissolution	Surface Water	Ingestion	○	--
						Dermal Contact	○	--
	Historical Groundwater Migration pre-HCIM	Groundwater Flow	Groundwater	Discharge	Surface Water	Ingestion	○	--
						Dermal Contact	○	--
					Aquatic Biota	Ingestion	--	○

Current and Future Potential Receptors

KEY

→ Potential Transport or Exposure Pathway

-- Incomplete Exposure Pathway

○ Potentially Complete Exposure Pathway

● Complete Exposure Pathway

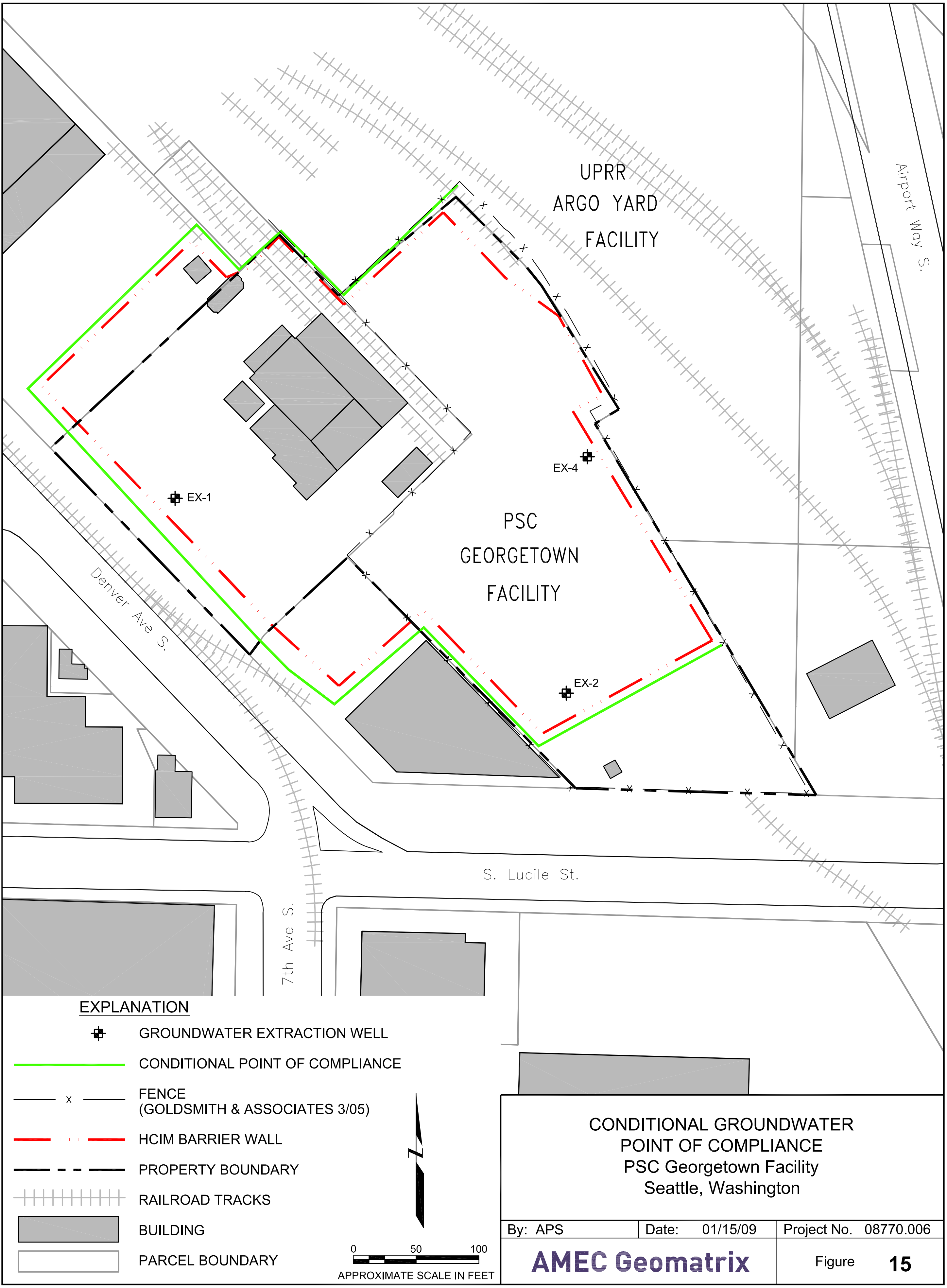
n/a = not applicable; no residents will live within the HCIM Area now or in the future.

HUMAN AND ECOLOGICAL
CONCEPTUAL SITE MODELS
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/10/09 | Project No.: 08770.006

AMEC Geomatrix

Figure 14



CONDITIONAL GROUNDWATER
POINT OF COMPLIANCE
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 15

Plot Date: 01/15/09 - 7:13am, Plotted by: adam.stenberg
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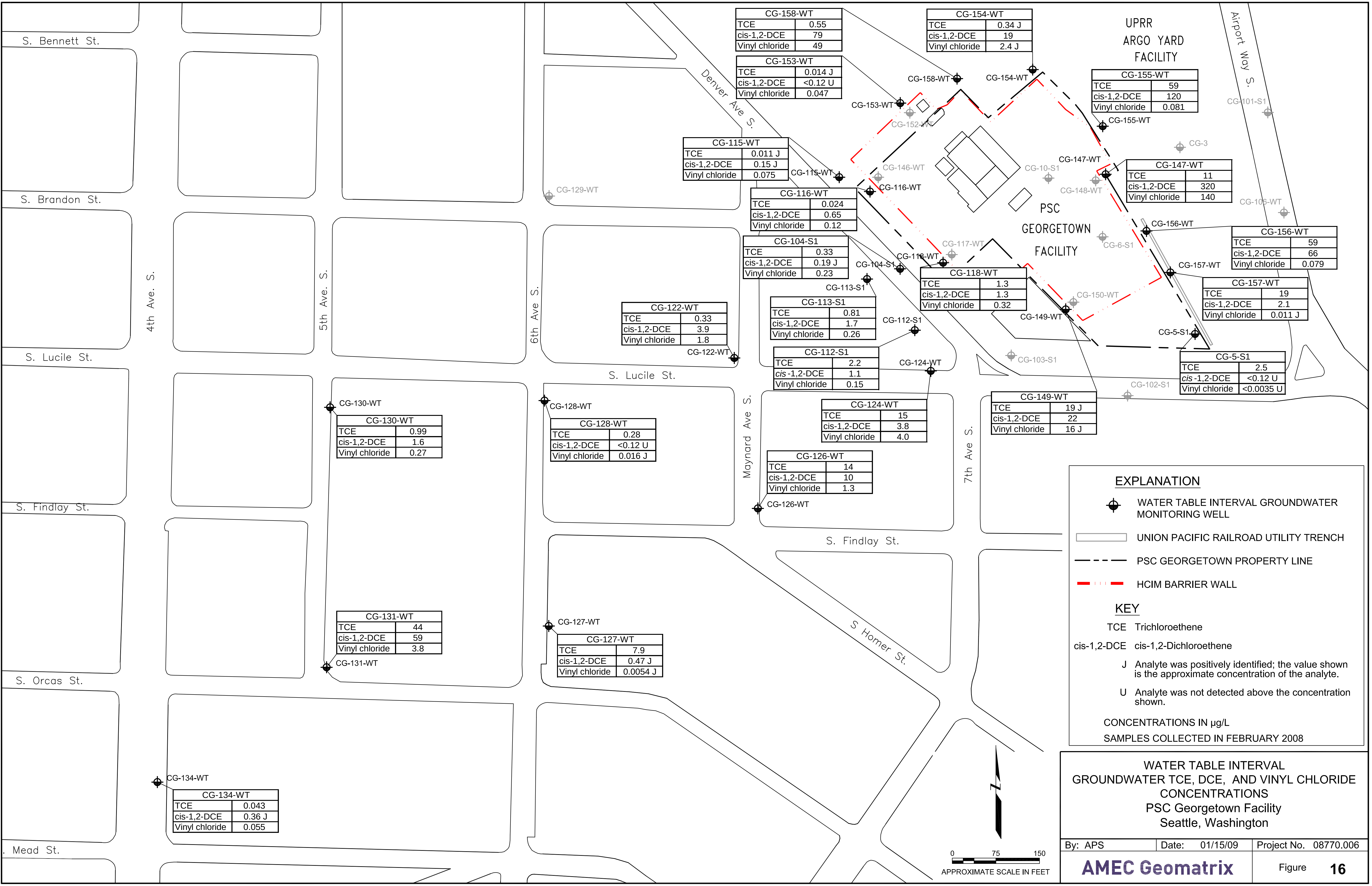


CG-158-WT	
TCE	0.55
cis-1,2-DCE	79
Vinyl chloride	49

CG-154-WT	
TCE	0.34 J
cis-1,2-DCE	19
Vinyl chloride	2.4 J

CG-153-WT	
TCE	0.014 J
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.047

CG-155-WT	
TCE	59
cis-1,2-DCE	120
Vinyl chloride	0.081

CG-115-WT	
TCE	0.011 J
cis-1,2-DCE	0.15 J
Vinyl chloride	0.075

CG-147-WT	
TCE	11
cis-1,2-DCE	320
Vinyl chloride	140

CG-116-WT	
TCE	0.024
cis-1,2-DCE	0.65
Vinyl chloride	0.12

CG-104-S1	
TCE	0.33
cis-1,2-DCE	0.19 J
Vinyl chloride	0.23

CG-156-WT	
TCE	59
cis-1,2-DCE	66
Vinyl chloride	0.079

CG-118-WT	
TCE	1.3
cis-1,2-DCE	1.3
Vinyl chloride	0.32

CG-157-WT	
TCE	19
cis-1,2-DCE	2.1
Vinyl chloride	0.011 J

CG-113-S1	
TCE	0.81
cis-1,2-DCE	1.7
Vinyl chloride	0.26

CG-122-WT	
TCE	0.33
cis-1,2-DCE	3.9
Vinyl chloride	1.8

CG-112-S1	
TCE	2.2
cis -1,2-DCE	1.1
Vinyl chloride	0.15

CG-5-S1	
TCE	2.5
cis -1,2-DCE	<0.12 U
Vinyl chloride	<0.0035 U

CG-124-WT	
TCE	15
cis-1,2-DCE	3.8
Vinyl chloride	4.0

CG-149-WT	
TCE	19 J
cis-1,2-DCE	22
Vinyl chloride	16 J

CG-130-WT	
TCE	0.99
cis-1,2-DCE	1.6
Vinyl chloride	0.27

CG-128-WT	
TCE	0.28
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.016 J

CG-126-WT	
TCE	14
cis-1,2-DCE	10
Vinyl chloride	1.3

CG-131-WT	
TCE	44
cis-1,2-DCE	59
Vinyl chloride	3.8

CG-127-WT	
TCE	7.9
cis-1,2-DCE	0.47 J
Vinyl chloride	0.0054 J

CG-134-WT	
TCE	0.043
cis-1,2-DCE	0.36 J
Vinyl chloride	0.055

EXPLANATION

⊕	WATER TABLE INTERVAL GROUNDWATER MONITORING WELL
▭	UNION PACIFIC RAILROAD UTILITY TRENCH
— - - -	PSC GEORGETOWN PROPERTY LINE
🟥	HCIM BARRIER WALL

KEY

TCE	Trichloroethene
cis-1,2-DCE	cis-1,2-Dichloroethene
J	Analyte was positively identified; the value shown is the approximate concentration of the analyte.
U	Analyte was not detected above the concentration shown.

CONCENTRATIONS IN µg/L

SAMPLES COLLECTED IN FEBRUARY 2008

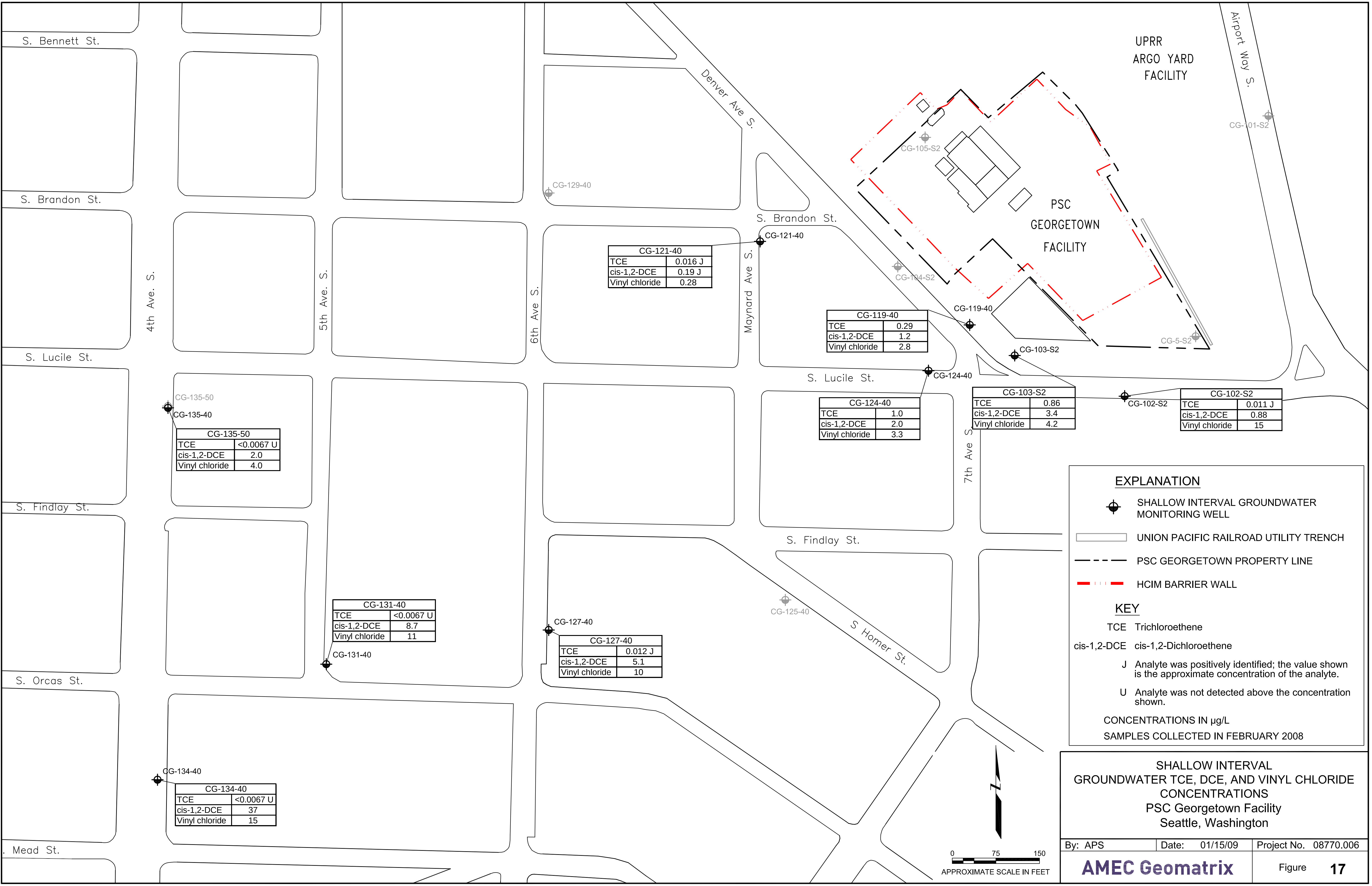
WATER TABLE INTERVAL GROUNDWATER TCE, DCE, AND VINYL CHLORIDE CONCENTRATIONS

PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix

Figure 16



EXPLANATION

⌖ SHALLOW INTERVAL GROUNDWATER MONITORING WELL

▭ UNION PACIFIC RAILROAD UTILITY TRENCH

— — — PSC GEORGETOWN PROPERTY LINE

— · — HCIM BARRIER WALL

KEY

TCE Trichloroethene

cis-1,2-DCE cis-1,2-Dichloroethene

J Analyte was positively identified; the value shown is the approximate concentration of the analyte.

U Analyte was not detected above the concentration shown.

CONCENTRATIONS IN μg/L

SAMPLES COLLECTED IN FEBRUARY 2008

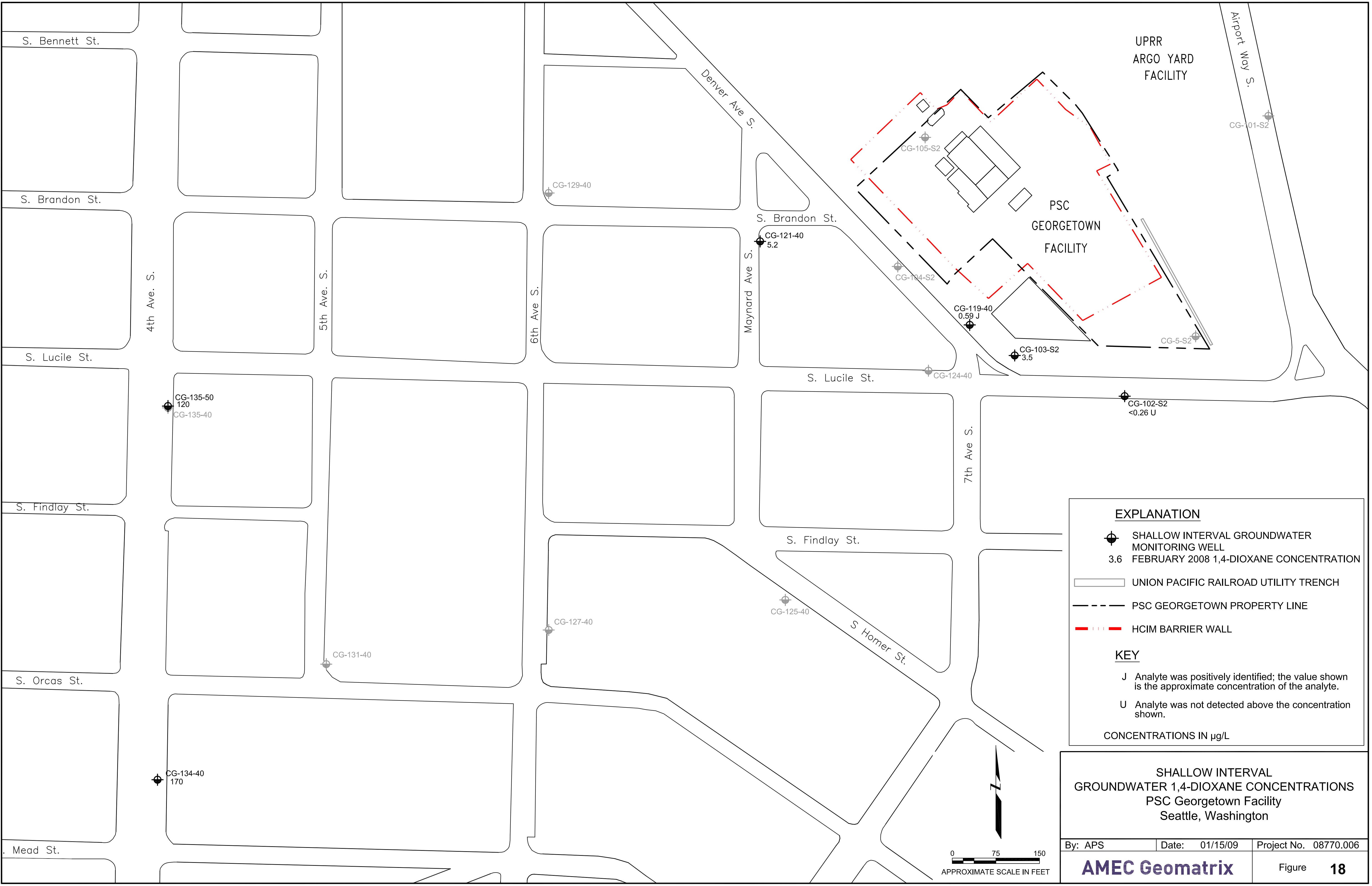
SHALLOW INTERVAL
GROUNDWATER TCE, DCE, AND VINYL CHLORIDE CONCENTRATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix

Figure 17

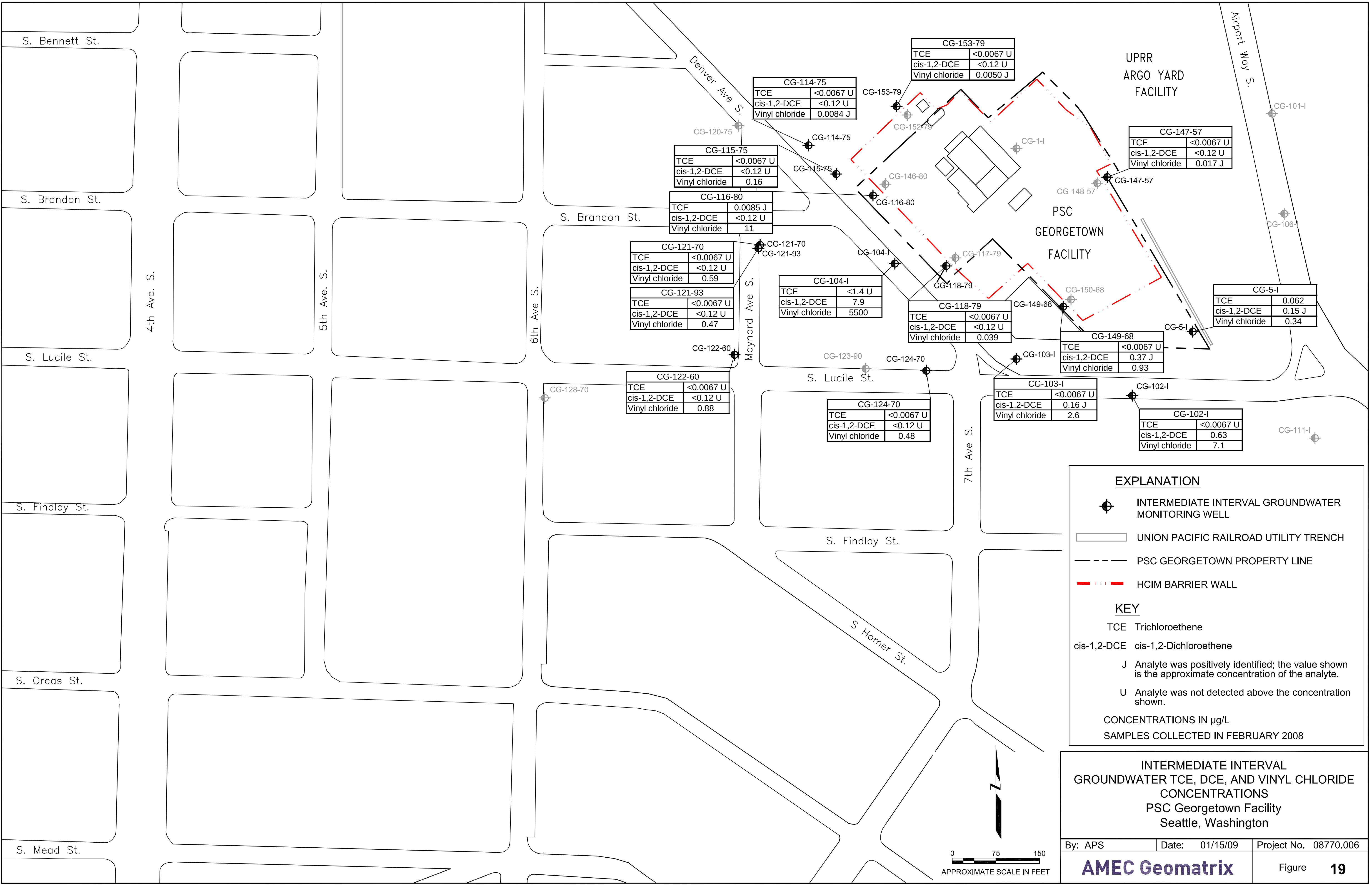
Plot Date: 01/15/09 - 7:25am, Plotted by: adam.stenberg
Drawing Path: S:\8770_2006\025_CAP-RevisedNov08\CAD\, Drawing Name: PSC-GT_GW-Data-SH_112408.dwg



SHALLOW INTERVAL
GROUNDWATER 1,4-DIOXANE CONCENTRATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS	Date: 01/15/09	Project No. 08770.006
AMEC Geomatrix		Figure 18

Plot Date: 01/15/09 - 7:35am, Plotted by: adam.stenberg
Drawing Path: S:\8770_2006\025_CAP-RevisedNov08\CAD\, Drawing Name: PSC-GT_GW-1-4D-SH_112408.dwg



CG-153-79	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.0050 J

CG-114-75	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.0084 J

CG-147-57	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.017 J

CG-115-75	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.16

CG-116-80	
TCE	0.0085 J
cis-1,2-DCE	<0.12 U
Vinyl chloride	11

CG-121-70	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.59

CG-104-I	
TCE	<1.4 U
cis-1,2-DCE	7.9
Vinyl chloride	5500

CG-121-93	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.47

CG-118-79	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.039

CG-5-I	
TCE	0.062
cis-1,2-DCE	0.15 J
Vinyl chloride	0.34

CG-149-68	
TCE	<0.0067 U
cis-1,2-DCE	0.37 J
Vinyl chloride	0.93

CG-122-60	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.88

CG-103-I	
TCE	<0.0067 U
cis-1,2-DCE	0.16 J
Vinyl chloride	2.6

CG-124-70	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.48

CG-102-I	
TCE	<0.0067 U
cis-1,2-DCE	0.63
Vinyl chloride	7.1

EXPLANATION

⊕	INTERMEDIATE INTERVAL GROUNDWATER MONITORING WELL
▭	UNION PACIFIC RAILROAD UTILITY TRENCH
— - -	PSC GEORGETOWN PROPERTY LINE
▬ · · ▬	HCIM BARRIER WALL

KEY

TCE	Trichloroethene
cis-1,2-DCE	cis-1,2-Dichloroethene
J	Analyte was positively identified; the value shown is the approximate concentration of the analyte.
U	Analyte was not detected above the concentration shown.

CONCENTRATIONS IN µg/L

SAMPLES COLLECTED IN FEBRUARY 2008

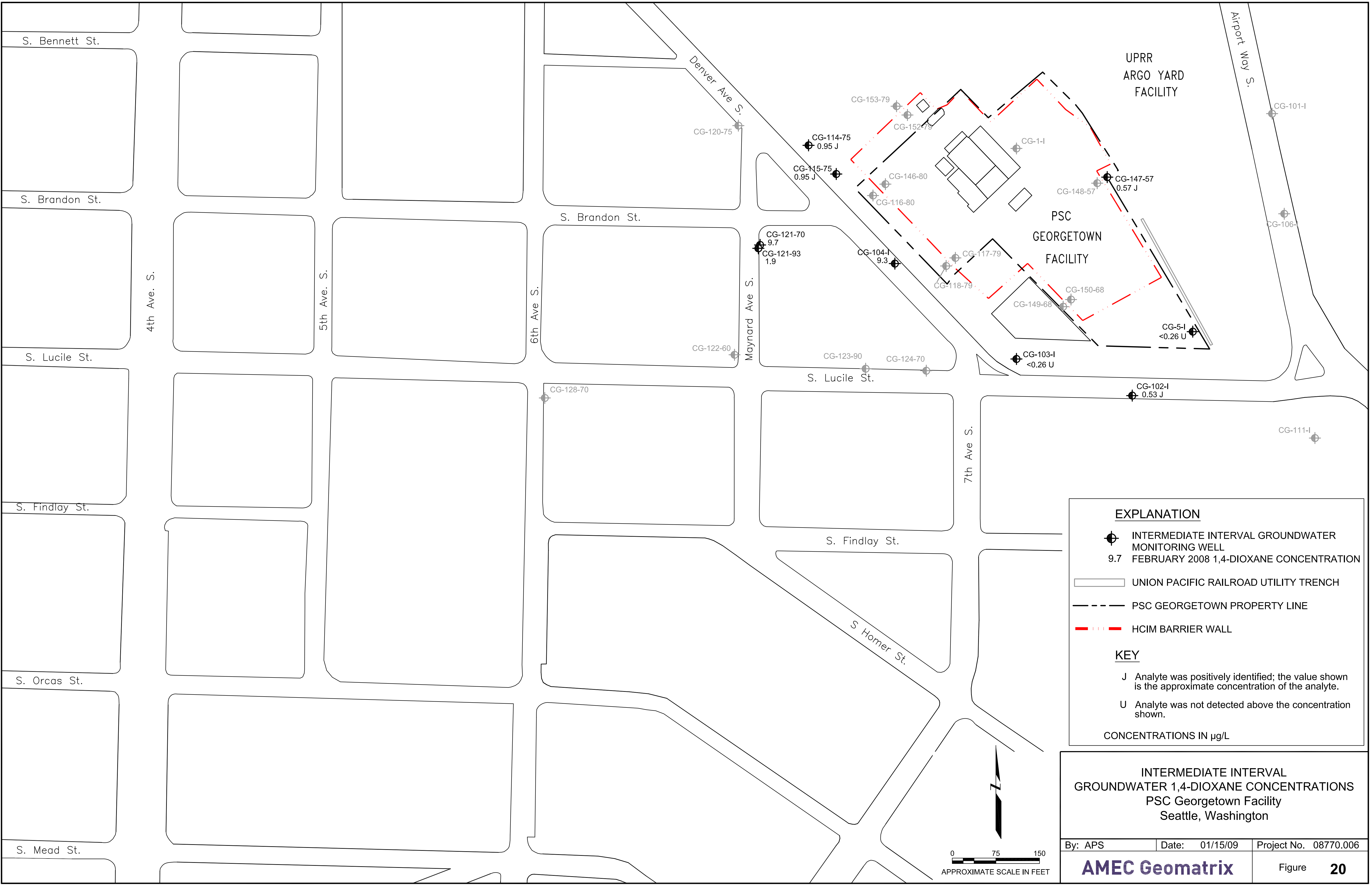
INTERMEDIATE INTERVAL GROUNDWATER TCE, DCE, AND VINYL CHLORIDE CONCENTRATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix

Figure 19

Plot Date: 01/15/09 - 7:36am, Plotted by: adam.stenberg
Drawing Path: S:\8770_2006\025_CAP-RevisedNov08\CAD\, Drawing Name: PSC-GT_GW-Data-INT_112508.dwg



EXPLANATION

⊕ INTERMEDIATE INTERVAL GROUNDWATER MONITORING WELL

9.7 FEBRUARY 2008 1,4-DIOXANE CONCENTRATION

▭ UNION PACIFIC RAILROAD UTILITY TRENCH

— — — PSC GEORGETOWN PROPERTY LINE

— · · — HCIM BARRIER WALL

KEY

J Analyte was positively identified; the value shown is the approximate concentration of the analyte.

U Analyte was not detected above the concentration shown.

CONCENTRATIONS IN µg/L

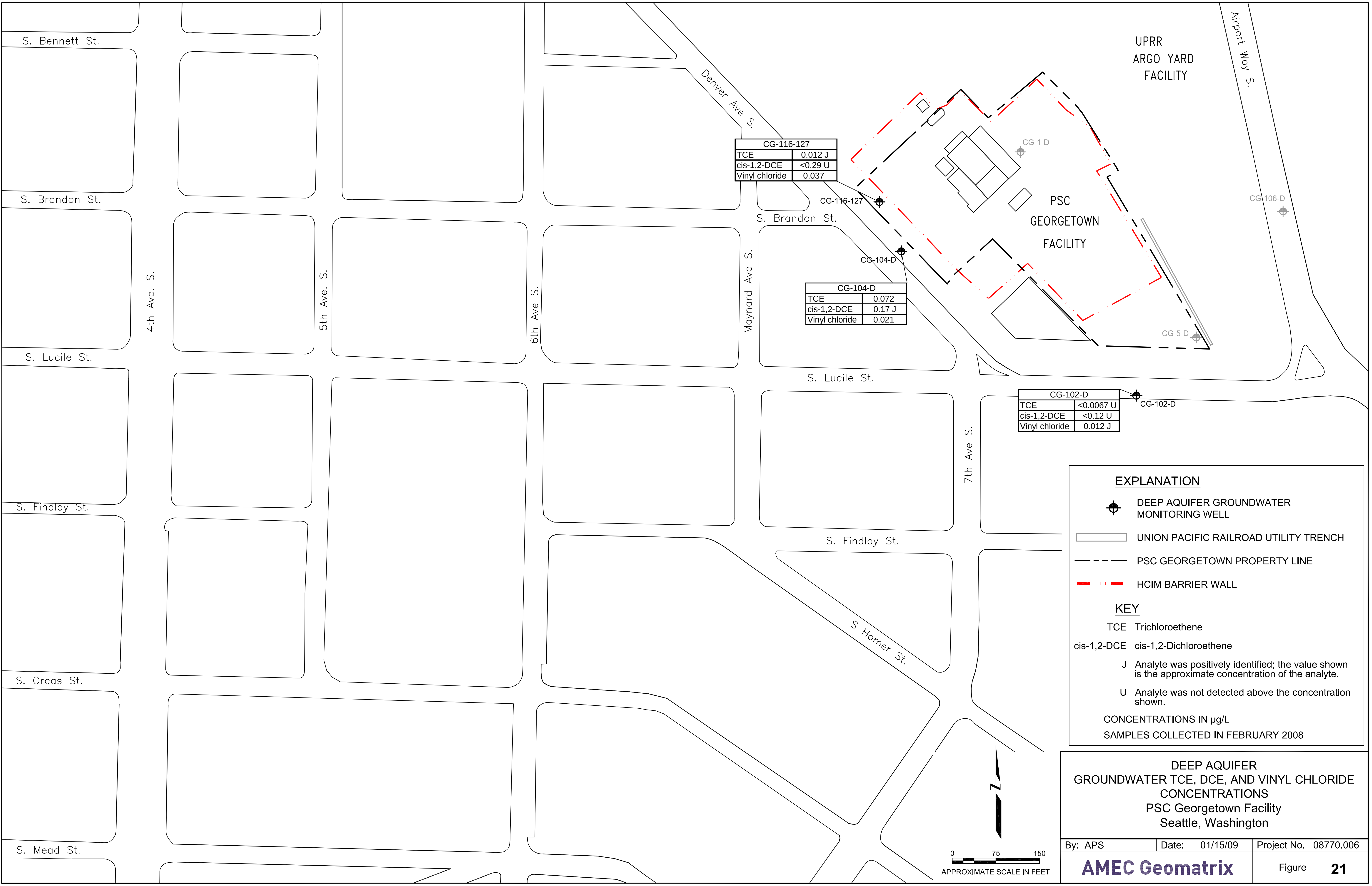
INTERMEDIATE INTERVAL GROUNDWATER 1,4-DIOXANE CONCENTRATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix

Figure 20

Plot Date: 01/15/09 - 12:12pm, Plotted by: adam.stenberg
Drawing Path: S:\8770_2006\025_CAP-RevisedNov08\CAD\, Drawing Name: PSC-GT_GW-1-4D-INT_112508.dwg



CG-116-127	
TCE	0.012 J
cis-1,2-DCE	<0.29 U
Vinyl chloride	0.037

CG-104-D	
TCE	0.072
cis-1,2-DCE	0.17 J
Vinyl chloride	0.021

CG-102-D	
TCE	<0.0067 U
cis-1,2-DCE	<0.12 U
Vinyl chloride	0.012 J

EXPLANATION

⊕ DEEP AQUIFER GROUNDWATER MONITORING WELL

▭ UNION PACIFIC RAILROAD UTILITY TRENCH

— - — PSC GEORGETOWN PROPERTY LINE

— · · — HCIM BARRIER WALL

KEY

TCE	Trichloroethene
cis-1,2-DCE	cis-1,2-Dichloroethene
J	Analyte was positively identified; the value shown is the approximate concentration of the analyte.
U	Analyte was not detected above the concentration shown.

CONCENTRATIONS IN µg/L

SAMPLES COLLECTED IN FEBRUARY 2008

DEEP AQUIFER GROUNDWATER TCE, DCE, AND VINYL CHLORIDE CONCENTRATIONS
PSC Georgetown Facility
Seattle, Washington

By: APS | Date: 01/15/09 | Project No. 08770.006

AMEC Geomatrix

Figure 21

Plot Date: 01/15/09 - 7:39am, Plotted by: adam.stenberg
Drawing Path: S:\8770_2006\025_CAP-RevisedNov08\CAD\, Drawing Name: PSC-GT_GW-Data-DEEP_110408.dwg

APPENDIX A

Implemented Interim Actions of the PSC Georgetown Site

APPENDIX A

IMPLEMENTED INTERIM ACTIONS AT THE PSC GEORGETOWN SITE

PSC has performed two interim remedial actions within the HCIM Area and one in the Outside Area.

A.1 HCIM AREA

In 1994 a soil vapor extraction (SVE) system was installed in the former north field area of the RCRA facility to recover VOCs and to limit the spread of volatile constituents present in the vadose zone. According to PSC, approximately 19,000 pounds (lb) of VOCs were removed from the vadose zone by the SVE system. The SVE system was turned off from February to August 1996 to allow the vadose zone to re-equilibrate; however, after resuming system operations, no significant increase in contaminant removal was observed. The SVE system was operated intermittently over the next eight years with diminished recovery of VOCs. Operation of the system was suspended on February 1, 2004.

In 2003 and 2004, PSC designed and constructed the hydraulic control interim measure (HCIM). The HCIM is designed to establish hydraulic control of contaminated groundwater in the immediate vicinity of the PSC RCRA facility and prevent future releases of contaminated groundwater downgradient. The HCIM involved installation of a subsurface barrier wall that surrounds the PSC RCRA facility source area. The wall forms the boundary between the HCIM Area and the Outside Area. It was constructed vertically from the ground surface to 52.5 - 88.5 feet below ground surface, and keyed approximately 2 feet into the aquitard beneath the facility. Barrier wall materials were tested for chemical compatibility with underlying groundwater prior to construction. Materials consist of a mixture of cement and highly plastic clay ("Impermix") resulting in a wall that is very low in permeability and, due to the clay content, is highly resistant to cracking, including desiccation cracks that are typical of concrete. This clay/cement wall is ideally suited to containing contaminated groundwater.

Components of the HCIM include:

- A low-permeability (less than 10^{-8} centimeters per second [cm/sec]) barrier wall designed to enclose, to the maximum extent practicable, source areas and contaminated groundwater and DNAPL above the aquitard at the RCRA facility;

- A groundwater recovery system within the containment area to maintain an inward hydraulic groundwater gradient;
- A groundwater (pre-)treatment system to treat recovered groundwater behind the wall before it is discharged to the King County Department of Natural Resources and Parks (KCDNRP) publicly owned treatment works (POTW); and
- A performance monitoring system designed to monitor groundwater levels and chemistry inside and outside the containment area. Monitoring is conducted to ensure compliance with the performance goal of a net inward hydraulic gradient and to demonstrate containment.

The existing groundwater recovery and pretreatment system consists of two extraction wells, an air stripper, and associated pumps and controls. Treated groundwater is discharged to a POTW under a permit issued by King County. Programs and systems have been implemented for operation, maintenance, inspection, and ongoing monitoring of the groundwater recovery and pretreatment system.

Contaminated vapors emitted by the air stripper are routed to carbon adsorption units. Here, VOCs are adsorbed before the gas stream is exhausted. VOC emission limits have been established to comply with local air authority regulations and to protect receptors (by ensuring that groundwater-sourced VOC levels in ambient air are acceptable at “reasonable maximally exposed” receptor points).

Additional, and more detailed, information about the HCIM system is included in the following documents:

- Final Design Document, Volumes I and II (April 2003)
- Performance Monitoring Plan (December 2003)
- Implementation Report (June 2004)
- Barrier Wall Evaluation Report (August 2004)
- annual Performance Monitoring Reports

A.2 OUTSIDE AREA

In 2002, PSC began implementing the Inhalation Pathway Interim Measure (IPIM). The IPIM is an integrated approach to prevent, or mitigate, exposure to VOCs in indoor air associated with volatilization from groundwater and/or soil (called “vapor intrusion”). The IPIM is a tiered system to evaluate groundwater and indoor air data to identify buildings that warrant further investigation or an interim measure. The IPIM components include:

- Shallow groundwater monitoring near buildings downgradient of the PSC property;
- Data collection (indoor air, ambient air, sub-slab soil gas, and groundwater) at individual downgradient properties, when warranted;
- Installation of vapor intrusion mitigation systems, including vapor barriers and depressurization systems, to eliminate/minimize vapor intrusion from the subsurface into buildings; and
- Long term monitoring to ensure: a) that mitigation systems continue to function as designed (and continue to protect indoor air quality); b) that un-mitigated buildings in areas where shallow groundwater VOCs are elevated, which have not appeared to require mitigation in the past, still do not need such protection; and, c) that un-mitigated buildings in areas where shallow groundwater VOCs were not elevated in the past, still do not need such protection (either because shallow groundwater VOC concentrations remain low or the buildings are tested to verify that mitigation is unnecessary).

The IPIM is implemented as a decision tree involving four tiers.

- Tiers 1 and 2: VOC data from shallow groundwater monitoring adjacent to residential (Tier 1) and commercial/industrial (Tier 2) properties are compared to approved, health-based “action levels” to identify properties where groundwater contamination is significant enough to pose a potential vapor intrusion threat. Such buildings require further investigation.
- Tier 3: Properties identified during Tiers 1 and 2 are evaluated to determine if property-specific data collection (including the collection of indoor air samples) is warranted, or if an interim measure (IM) should be implemented. For properties evaluated in this tier, a report is prepared following the Tier 3 investigation with a recommended course of action (e.g., return to Tier 1 or 2 for further monitoring, or implement mitigation) (Table A-1).
- Tier 4: Owners of properties identified for an IM are offered vapor intrusion mitigation systems to eliminate/minimize contamination of indoor air via vapor intrusion. Mitigation systems are typically radon-prevention depressurization measures that collect soil gases from beneath the structure and vent the gases above the roof of the building. Periodic inspections and long-term monitoring are included to verify each system is achieving remedial goals (Table A-2).

More information about the IPIM program is contained in the following documents:

- Revised IPIM Work Plan (August 2002)
- Revised IPIM Tech Memo #1 (February 2003)
- FS Tech Memo #3 (May 2006)
- Quarterly Progress Reports
- individual Tier 3 evaluation reports and Tier 4 post-mitigation “de-pressurization design” reports

ATTACHMENTS:	Table A-1	GT IPIM Tier 3 Status Report
	Table A-2	IPIM Tier 4 Finished Status

TABLE A-1

GT IPIM TIER 3 STATUS REPORT
PSC Georgetown Facility
Seattle, Washington

Building Address	Access Agreement	Site Walk Completed	SAP[1] Submitted	SAP[1] Approved	Sampling Completed	Results Received	Data Validation Received	Report Submitted	Proposed Action[2]	Report and Action Approved by Ecology
747 S. Lucile St.	Yes	5/14/2003	6/9/2003	8/4/2003	8/28/2003	9/15/2003	11/7/2003	1/15/04, 2/27/04	Tier 4	Yes, revision approved
412 S. Lucile St.	Yes	N/A	6/9/2003	8/4/2003	8/28/2003	9/15/2003	11/7/2003	1/12/04, 2/27/04	Tier 4	Yes, revision approved
521 S. Brandon St.	Yes	5/14/2003	6/9/2003	8/4/2003	8/28/2003	9/15/2003	11/7/2003	1/15/04, 2/27/04	NFA, monitor gw wells nearby	Yes, revision approved
5506 6th Ave. S.	Yes	7/10/2003	8/8/2003	8/12/2003	9/25/2003	10/10/2003	11/14/2003	1/15/04, 2/27/04	Tier 3 Monitoring in 2004	Yes, revised report, resampled 4/30/04, approved NFA
502-580 S. Lucile St.	Yes	7/10/2003	8/8/2003	8/15/2003	9/25/2003	10/10/2003	11/14/2003	1/15/04, 2/27/04	Tier 3 Monitoring in 2004	Yes, revised report, resampled 4/30/04, approved NFA
5706 2nd Ave. S	Yes	8/6/2003	9/3/2003	9/11/2003	11/13/2003	12/4/2003	1/15/2003	2/12/04	NFA, monitor gw wells nearby	Yes
637 S. Lucile St.	Yes	8/7/2003	9/3/2003	9/12/2003	11/13/2003	12/4/2003	1/19/2004	2/16/04	NFA, monitor gw wells nearby	Yes, Owner has not responded to PSC request to resample
308 S. Orcas St.	Yes	8/7/2003	9/3/2003	9/24/2003	11/21/2003	12/12/2003	1/15/2003	2/20/04	NFA, monitor gw wells nearby	Yes
202-228 S. Mead St.	Yes	8/8/2003	9/3/2003	9/24/2003	11/13/2003	12/4/2003	1/15/2003	2/12/04	NFA, monitor gw wells nearby	Yes, Ecology requests installation offer to owner.
5419 Maynard Ave.	Yes	8/8/2003	9/5/2003	9/24/2003	11/21/2003	12/15/2003	1/15/2003	2/20/04	NFA, monitor gw wells nearby	Yes
5412 6th Ave.	Yes	8/8/2003	9/8/2003	9/24/2003	11/21/2003	12/15/2005	1/15/2003	2/20/04	NFA, monitor gw wells nearby	Yes
5900 1st Ave. S. (Oly Med)	Yes	8/12/2003	9/10/2003	9/24/2004	10/14/2004	11/21/2004	12/10/2004	1/10/05	Mitigate warehouse area only	No. Need to sample manufacturing area for trichloroethene.
5600-5620 6th Ave. S.	Yes	8/13/2003	9/10/2003	10/24/2003	11/18/2003	12/8/2003	1/15/2003	2/16/04	NFA, monitor gw wells nearby	Yes
620 S. Orcas St.	Yes	8/14/2003	9/10/2003	10/15/2003	1/30/2004	3/9/2004	3/24/2004	4/29/04	NFA, monitor gw wells nearby	Yes
5801 2nd Ave. S. (Capital Ind.)	Yes	9/23/2003	10/22/2003	12/12/2003	Hold					Previous sampling locations unavailable due to construction
5501-5519 6th Ave. S.	Yes	11/5/2003	12/3/2003	12/10/2003	1/30/2004	3/9/2004	3/24/2004	4/28/04	NFA, monitor gw wells nearby	Yes
624 S. Findley St.	Yes									
5700 3rd Ave. S. (Blaser)	Yes									
215/217 S. Findlay St.	Yes	8/25/2004	9/22/2004	9/27/2004	11/24/2004	1/26/2005	2/3/2005	2/18/05	Resample	Yes, Resample to be scheduled
301-313 S. Findlay St.	Yes (Owner)									Awaiting access agreement from tenant
222 S. Orcas St.	Yes	8/19/2004	N/A	N/A	10/14/2004	11/21/2004	12/10/2004	1/28/05	NFA, monitor gw wells nearby	Yes
226 S. Orcas St.	Yes									
650-670 S. Lucile St.	Yes	5/22/2003	08/26/04	Pending						Ecology requests additional changes to SAP. SAP being revised and sent to owner for approval
5701 6th Ave. S (Design Ctr)	Yes	4/28/2003	06/04/04	07/04/04	7/25/2004	8/10/2004	8/27/2004	9/24/04	NFA, monitor gw wells nearby	Yes, Voluntary resample by owner in December
5602 2nd Ave S.	Yes	2/9/2005	4/8/2005	4/22/2005						
5606 2nd Ave. S.	Yes	3/8/2005	4/8/2005	4/22/2005						
5610 2nd Ave. S.	Yes	2/9/2005	4/8/2005	4/22/2005						
5610 4th Ave. S	Pending									
5516 3rd Ave. S. (Art Brass)	Declined Sampling									
220 S. Findlay St.	Pending									
203 S. Orcas St.	Declined Sampling									

Notes:
1. SAP = Sampling and Analysis Plan.
2. For description of Tiers see text; NFA = No further action; gw = groundwater.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
672/674 S. Lucile St. Basement Construction	Walter Day	206.363.3304	2/20/04	3/2/04	3/12/04	Yes	Yes	Yes	Post-Installation Pressure Field Test (7/2/04): P-1: -0.095 P-2: -0.007
612 S. Lucile St. Basement Construction	Delores and Lawrence Brewer	206.762.4737	4/7/03						Suggest taking this structure off of the Tier 4 List- there are no utilities hooked up and no plans by owners to let anyone live there. Will be sending a letter to Ecology requesting that this structure be taken off of the Tier 4 list.
616 S. Lucile St. Basement Construction	Delores and Lawrence Brewer	206.762.4737	4/7/03						Ecology has sent a letter
611/613 S. Brandon St. Crawl Space Construction	Delores and Lawrence Brewer	206.762.4737	4/7/03	6/17/03	6/24/2003	Yes	Yes	Yes	Installation is complete. Pressure field extension not measured in crawl space systems.
615 S. Brandon St. Crawl Space Construction	Chuck Gonzales	206.762.7997	5/9/03	7/14/03	8/4/03	Yes	Yes	Yes	Installation is complete. Pressure field extension not measured in crawl space systems.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
605 S. Brandon St. Slab-on-Grade and Crawl Space	Landlord: Grace Harvey	206.682.9797		6/30/04	7/2/04	Yes	Yes	Yes	Installation is Complete. Post-installation pressure field test (7/1/04) P-1: -0.048 P-2: -0.162
5403 Maynard Ave. S. Basement Construction	Ruth Schmidt and Albert Maertens	206.762.7970	4/7/03	6/16/03	6/30/2003	Yes	Yes	Yes	Installation is complete. Post-installation pressure field test (7/2/04): P-1: -0.069 P-2: -0.150 P-3: -0.065
5409 Denver Ave S. Basement Construction	Mr. Watson	No telephone	4/7/03						Do not want a system installed. Ecology has agreed to remove this residence from the Tier 4 List.
601 S. Brandon St. Crawl Space Construction	Landlord and Tenant: James Harvey	206.682.9797 or 206.764.1223		6/29/04	7/2/04	Yes	Yes	Yes	Pressure field extension not measured in crawl space systems.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
211 S. Orcas St. Basement Construction	Mark Krylov	206.920.7033	10/14/03 and 9/10/04					Mr. Kryilov will call and let us know if he wants a system. He is not thrilled with the available options for routing the system.	Waiting to hear back from Mr. Krylov- he is not sure he wants an installation done. Have already done one site visit to his home.
215 S. Orcas St. Basement Construction	Nathan Korpela	206.377.6618 (work)	9/22/03	10/14/03	11/13/03	Yes	Yes	Yes	Installation is Complete Post-Installation Pressure Field Test (7/1/04): P-1: -0.088 P-2: -0.037 Third test hole was not accessible for testing.
217 S. Orcas St. Basement and Crawl Space Construction	Ray and Joanne Ridout	206.818.4361 Cell phone number: 206.818.3697	8/28/03	11/12/03	12/8/03	Yes	Yes	Yes	Installation is complete. Post-installation pressure field test (7/1/04): P-1: -0.016 P-2: -0.015

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
227 S. Orcas St. Basement Construction	Owner: Andrew Foley Tenant: Lex Mathis	Owner: 206.767.7800 Tenant: 206.767.1155	6/30/04	7/12/04	7/15/04	Yes	Yes	Yes	Installation is complete. Post installation pressure field test (11/29/04): P-1: -0.015 P-2: -0.017 P-3: -0.012 P-4: -0.008
404 S. Orcas St. Slab-on-Grade Construction	Sue Lewis	206.763.9230	6/20/03	7/16/03	8/8/2003	Yes	Yes	Yes	Installation is complete. Post-installation pressure field test (7/2/04): P-1: -0.018 P-2: -0.015
406 S. Orcas St. Basement Construction	Martin Smith	206.368.5548	7/18/03	8/28/03	9/4/03	Yes	Yes	Yes	Installation is complete. Post-installation pressure field test (7/2/04): P-1: -0.017 P-2: -0.037
412 S. Orcas St. Basement Construction	Tyson Schellhorn	206.762.4456	6/20/03	7/16/03	7/31/03	Yes	Yes	Yes	Installation is complete. Post-Installation Pressure Field Test (4/23/04): Test reading in elevated slab region: -0.015

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
5602 2nd Ave. S. Basement Construction	Owner: Milo and Sharon Perovich Tenant: Ken Tate	Owner: 206.243.5708 Tenant: 206.767.5323							Property moved to Tier 3.
5606 2nd Ave. S. Basement Construction	Owner: Milo and Sharon Perovich Tenant: Michelle Smith	Owner: 206.243.5708 Tenant: 206.764.8881							Property moved to Tier 3.
5610 2nd Ave S. Basement Construction	Owner: Milo and Sharon Perovich Tenant: Ken Tate	Owner: 206.243.5708 Tenant: 206.767.9790							Property moved to Tier 3.
214 S. Findlay St. Unknown Constructon	Charles Bauer	206.762.0599							Property moved to Tier 3.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
218 S. Findlay St. Basement Construction	Owner: David Gaffney, Lorraine Sprinkle Tenant: Arthur Donnelly	Owner: 206.767.2804 Tenant: 206.612.3018	8/28/03	9/25/03	10/1/03	Yes	Yes	Yes	Installation is complete. Post-installation pressure field test (4/23/04): P-1: -0.057 P-2: -0.033
218 ½ S. Findlay St. Open Crawl Space Construction	Owner and Tenant: David Gaffney, Lorraine Sprinkle	206.767.2804	8/28/03						Installation will not be needed at 218 ½ S. Findlay- house is on stilts. Ecology has agreed to remove this house from the Tier 4 list.
317 S. Lucile St. Unknown Construction	Charles Anderson	Unknown							Do not want a system installed. Ecology has agreed to remove this residence from the Tier 4 List.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
5601 2nd Ave. S. Crawl Space Construction	Owner: Joseph Hasson Tenant: Bob Schenck and Loretta Miller	Owner: 206.323.0203 Owner Cell phone: 206.334.0285 Tenant phone: 206.852.2781	8/27/03	9/3/03	9/12/03	Yes	Yes	Yes	Ecology wants indoor air sampling at this location or at another home on the block in the spring. Pressure field extension not measured in crawl space systems.
5607 2nd Ave S. Crawl Space Construction	Owner: Joseph Hasson Tenant: Garland Massey	Owner: 206.323.0203 Owner Cell phone: 206.334.0285 5607 Tenant phone: 206.763.3491	8/29/03	9/4/03	9/12/03	Yes	Yes	Yes	Installation is complete. Ecology wants indoor air sampling at this location or at another home on the block in the spring. Pressure field extension not measured in crawl space systems.
5607 ½ 2nd Ave. S. Crawl Space Construction	Owner: Joseph Hasson Tenant: Lewis Ethridge	Owner- 206.323.0203 Owner Cell phone- 206.334.0285 Tenant phone: 206.766.8649	10/22/03	10/22/03	2/26/04	Yes	Yes	Yes	Pressure field extension not measured in crawl space systems.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
5609 2nd Ave S. Crawl Space Construction	Edwin Schlapfer	Seattle phone: 206.767.4710 Colorado phone: 970.728.5214	7/18/03	9/2/03	9/4/03	Yes	Yes	Yes	Pressure field extension not measured in crawl space systems.
118 S. Findlay St. Building Has Been Demolished	Tom Wells	Unknown							Ecology has sent a letter- property is removed from Tier 4 list unless redeveloped for residential use.
121 S. Findlay St. Crawl Space Construction	Owner: Joseph Hasson Tenant: Anthony LaChapell	Owner: 206.323.0203 Owner Cell phone: 206.334.0285 Tenant does not have a phone	8/27/03	9/24/03	9/29/03	Yes	Yes	Yes	Installation is complete. Ecology wants indoor air sampling at this location or at another home on the block in the spring. Pressure field extension not measured in crawl space systems.
122 S. Findlay St. Crawl Space Construction	Johan Rismoen	206.762.9138	7/18/03	8/26/03	9/5/03	Yes	Yes	Yes	Installation is complete. Pressure Field Extension Not Measured in Crawl Space Systems.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
123 S. Findlay St. Crawl Space Construction	Owner: Joseph Hasson Tenant: Fred (D) Brown III	Owner: 206.323.0203 Owner Cell phone: 206.334.0285 Tenant: Unknown	8/28/03	9/24/03	9/29/03	Yes	Yes	Yes	Installation is complete. Ecology wants indoor air sampling at this location or at another home on the block in the spring. Pressure field extension not measured in crawl space systems.
125 S. Findlay St. Crawl Space Construction	Owner: Joseph Hasson Tenant: Sandy McMurray	Owner: 206.323.0203 Owner Cell phone: 206.334.0285 Tenant: 206.768.2734 Tenant cell phone: 206.769.0885	8/27/03	9/4/03	9/12/03	Yes	Yes	Yes	Installation is complete. Ecology wants indoor air sampling at this location or at another home on the block in the spring. Pressure field extension not measured in crawl space systems.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
128 S. Mead St. Crawl Space Construction	Owner: Dale and Dorothy Spitzock Tenant: John Grunden	Owner: 206.431.0628 Tenant: Unknown	9/17/03	10/20/03	12/8/03	Yes	Yes	Yes	Installation is complete. Pressure field extension not measured in crawl space systems.
132 S. Mead St. Crawl Space Construction	Owner: Dale and Dorothy Spitzock Tenant: Jason Tupper	Owner: 206.431.0628 Tenant: 206.762.0930	9/17/03	9/22/03	10/1/03	Yes	Yes	Yes	Installation is complete. Pressure field extension not measured in crawl space systems.
134 S. Mead St. Crawl Space Construction	Owner: Dale and Dorothy Spitzock Tenant: Steven Richards	Owner: 206.431.0628 Tenant: 206.762.2014	9/17/03	9/23/03	10/1/03	Yes	Yes	Yes	Installation is complete. Pressure field extension not measured in crawl space systems.

TABLE A-2

IPIM TIER 4 FINISHED STATUS

PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
5607 4th Ave. S. Unknown Construction	Owner: Unknown	Tenant: Unknown							Ecology sent letter to owner stating that we would no longer pursue putting a system in at this location. If owner decides they would like a system, they will need to contact either Ecology or PSC.
402 S. Lucile St. Crawl Space Construction	Owner: Genevieve Holter Tenant: David James	Owner: 206.767-3776 Tenant: 206.762.5473	7/1/04	7/13/04	7/15/04	Yes	Yes	Yes	
406 S. Lucile St. Basement Construction	Owner: Genevieve Holter Tenant: John McAlonan	Owner: 206.767-3776 Tenant: 206.767-3776	5/17/04	6/2/04	6/9/04	Yes	Yes	Yes	Post installation pressure testing (6/22/04): P-1: -0.159 P-2: -0.165
412 S. Lucile St. Basement Construction	Owner: Genevieve Holter Tenant: Maurice Johnson	Owner: 206.767-3776 Tenant: 206.767.3320	5/17/04	6/1/04	6/4/04	Yes	Yes	Yes	Post installation pressure testing (6/22/04) P-1: -0.175 P-2: -0.033

TABLE A-2

IPIM TIER 4 FINISHED STATUS
PSC Georgetown Facility
Seattle, Washington

Building Address/ Construction Type	Contact Name	Contact Phone Number	Date/Time for Site Visit	Installation Date	Electrical Wiring Approved by City	Drawings Received from Contractor	Report Submitted to Ecology	Tier 4 Approved by Ecology	Notes
416 S. Lucile St. Basement Construction	Owner: Genevieve Holter Tenant: Robert Griffith	Owner: 206.767-3776 Tenant: 206.322.1210	5/17/04	6/3/04	6/4/04	Yes	Yes	Yes	Post installation pressure testing: P-1: -0.027 P-2: -0.023
707 S. Lucile St. Western Trailer	Mark Terrana	206.762.7850		Installation Completed 2/2/05	2/2/05	Yes	4/7/05	Not Yet	Post installation pressure testing: P-1: -0.101 P-2: -0.042 P-3: -0.091
202-228 S. Mead St. Slab-On Grade Construction	Owner: Arthur Price	206.283.7205	10/8/2004 2:00 pm						Waiting for owner to draft an access agreement.

APPENDIX B

How Cleanup Standards (Cleanup Levels and Points of Compliance) were chosen for the PSC FS and dCAP

APPENDIX B

HOW CLEANUP STANDARDS (CLEANUP LEVELS AND POINTS OF COMPLIANCE) WERE CHOSEN FOR THE PSC FS AND CAP

Section 4 of the CAP summarizes how the cleanup standards for the site were established and Tables 4 through 8 include the media cleanup levels themselves. This appendix contains additional, and more detailed information, regarding how the CAP's cleanup standards were derived.[1]

B.1 APPLICABLE STATE AND FEDERAL LAWS

The cleanup action must comply with MTCA (Chapter 173-340 WAC) and all applicable state and federal laws, in accordance with WAC 173-340-350, WAC 173-340-710, and the requirements of the PSC permit. "Applicable" requirements mean those regulatory cleanup standards; standards of control; and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a COC, remedial action, location, or other circumstance at the site and that are applicable under law.

At Superfund and MTCA sites the acronym *ARARs* is utilized to refer to those cleanup requirements that are "applicable" (as discussed above), or "relevant and appropriate." "Relevant and appropriate" requirements are regulatory requirements or regulatory guidance that do not apply to the facility under law but which address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the cleanup. WAC 173-340-710(4) contains a description of requirements and criteria for determining when non-applicable regulatory requirements and/or guidance should be considered relevant and appropriate.

ARARs are often identified as chemical-specific, location-specific, or remedial action-specific. A number of regulations include requirements in more than one of these three categories.

The operational portions of the PSC RCRA facility are closed; however, corrective actions are ongoing and require compliance with the Washington Dangerous Waste Regulations (WAC 173-303) and federal RCRA regulations (Code of Federal Regulations [CFR] Title 40, Parts 240-299, and the facility permit). Any cleanup action taken must comply with other applicable

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[1] The toxicity values used to calculate cleanup levels for trichloroethene (Chemical Abstract Service # 79-01-6) and tetrachloroethene (Chemical Abstract Service # 127-18-4) were updated to be consistent with Ecology Guidance (see: https://fortress.wa.gov/ecy/clarc/FocusSheets/TCE%20PCE%20Oct%202004%20Final.pdf).

laws and regulations (United States Code [U.S.C.] Title 42, Ch. 6901 et seq.). The applicable requirements under the Dangerous Waste and RCRA regulations pertain primarily to management of remediation wastes and general compliance issues with the Permit. Corrective action requirements under RCRA and the Dangerous Waste regulations are addressed under the Permit and in the MTCA regulations, which include specific and extensive cleanup requirements.

The following state and local ARARs were considered in selecting the cleanup action:MTCA regulations (WAC 173-340),

- Dangerous Waste Regulations (WAC 173-303),
- Water Quality Standards for Washington Surface Waters (WAC 173-201A),
- Natural Background Soil Metals Concentrations in Washington State (Ecology, 1994),
- State Environmental Policy Act (Revised Code of Washington [RCW] 43.21C),
- State of Washington Worker Safety Regulations,
- State and Local Air Quality Protection Programs.

The following federal ARARs were considered in selecting the cleanup action:

- RCRA regulations (40 CFR Parts 240-299),
- Toxic Substances Control Act (TSCA) regulations for PCB-contaminated soils (40 CFR 761)
- Clean Water Act (33 U.S.C. 1251 et seq.) Section 304 National Recommended Water Quality Criteria,
- Clean Air Act (42 U.S.C. 7401 et seq.),
- Federal Worker Safety Regulations.

B.2 CLEANUP STANDARDS

For the areas addressed by this CAP, cleanup levels must be protective of the pathways described in the CSM (Section 3.3). At a minimum, cleanup levels for impacted soil within the vadose zone and impacted groundwater within the water table depth interval must be met for the following media exposure pathways:[2]

- *Soil*
    a) industrial direct human exposure pathways (ingestion, inhalation, dermal absorption);

    b) the soil-to-indoor air inhalation pathway (vapor intrusion); and,

    c) the soil-to-groundwater pathway;

- *Groundwater*
    a) the groundwater-to-surface water pathway. Duwamish Waterway-specific surface water standards must be met at the groundwater point of compliance (even though surface water cleanup levels are concentrations derived to be protective of surface water quality); and,

    b) the groundwater-to-indoor air inhalation pathway (vapor intrusion).

For groundwater within the shallow and intermediate depth intervals, and within the deep aquifer, the groundwater exposure pathways listed above (other than those related to vapor intrusion) must be met. The deep aquifer is not currently used as a source of drinking water, and due to naturally high levels of dissolved solids, manganese, and iron, it is not likely to be used as a source of drinking water in the foreseeable future. However, Ecology has determined that cleanup levels for the deep aquifer must allow for the possibility of direct ingestion of water from this aquifer in the future. Therefore, cleanup levels for the deep aquifer must additionally include consideration of levels protective of drinking water.

B.2.1 Point of Compliance

The MTCA regulations specify points of compliance (POCs) for various contaminated media. MTCA defines both a SPOC and an alternative CPOC. The POC applies to all soil, groundwater, air, or surface water at or adjacent to any location where releases of hazardous substances have occurred or that has been impacted by releases from the location. Site-specific conditions determine whether a SPOC or CPOC would be more appropriate for a site. A CPOC is usually defined only for groundwater or surface water; however, it may also be defined for soil under some circumstances. A CPOC is typically established at a specific

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[2] Unless containment (capping) is chosen.

location as near as possible to the source of the release. Several requirements are specified in the MTCA regulations for establishing a CPOC, as discussed in more detail below. A common situation for use of a CPOC is multiple sources of groundwater contamination and/or plumes on a responsible party's property. In these cases a CPOC is often established at the downgradient property boundary. However, under certain circumstances a CPOC may be established beyond the property boundary if Ecology and any landowners located between the source area and the CPOC approve the CPOC before it is incorporated into a final cleanup action.

As described in the RI Report, affected media at the PSC facility include soil and groundwater. Points of compliance (POCs) for soil and groundwater are established separately and are based on the potential exposure pathways associated with the two media. The regulatory requirements for POCs in soil and groundwater are summarized in Section B.2.1.1 and 2.1.2 below.

B.2.1.1 Soil Point of Compliance

The regulatory requirements for a soil POC are presented in WAC 173-340-740(6). The requirements depend on the relevant exposure pathway. Therefore, MTCA can require different soil POCs for different COCs. The regulatory requirements are as follows.

- For soil COCs whose cleanup levels are based on protection of groundwater or the vapor/inhalation pathway, a SPOC (soils throughout the site, from the ground surface to the uppermost water table) must be used.
- For soil COCs whose cleanup level is based on direct human contact with the contamination, the POC must include the soils throughout the site from the ground surface to a depth of 15 feet bgs (if the water table is present at a depth greater than 15').
- For soil COCs whose cleanup levels are based on ecological exposure, additional specific requirements are presented in WAC 173-370-7490(4).

The soil POCs apply to soil at the surface and beneath the surface affected by releases. For the purposes of the PSC CAP, the soil SPOC extends from the ground surface to the water table (at approximately 10 feet bgs).[3] Earthen materials at greater depths are not considered "soil" for the purpose of setting a POC, and soil cleanup levels do not apply. Affected media at depths

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[3] Soil cleanup levels in the CAP were established for protection of human exposure; no soil cleanup levels were established based on ecological exposures.

below the water table (e.g., the saturated zone) are addressed using groundwater cleanup levels.[4]

Although cleanup levels must be attained at a particular POC, remedial actions may rely primarily on containment of waste or affected soil. When containment is chosen as the cleanup action there is no POC, since cleanup levels do not need to be achieved. WAC 173-340-740(6)(f) states that a site may "be determined to" comply with soil cleanup standards if the following conditions are met and approved by Ecology:

- The selected cleanup action is determined by Ecology to be permanent to the maximum extent practicable;
- The selected cleanup action is determined by Ecology to be protective of human health and the environment;
- The selected cleanup action uses institutional controls that prohibit or limit activities that could interfere with the long-term effectiveness of the containment system;
- The selected cleanup action incorporates compliance monitoring and periodic reviews to ensure the long-term integrity of the containment system; and
- The types, levels, and amount of hazardous substances and affected soil are specified in the CAP, as well as methods to prevent migration and contact with the substances.

Since containment is included as a component of PSC's proposed cleanup action, the action will be designed to comply with these five bulleted requirements. For contaminated site soils not being capped/covered (contained), the soil POC includes all soil from the land surface to the water table (the SPOC).

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[4] In establishing the soil POC at a site, it is appropriate to review the MTCA definition of soil set forth in WAC 173-340-200:

- "Soil" means a mixture of organic and inorganic solids, air, water, and biota that exists on the earth's surface above bedrock, including material of anthropogenic sources, such as slag or sludge.
- "Soil biota" means invertebrate multicellular animals that live in the soil or in close contact with the soil.

Based on these definitions, taken together, it is apparent that the MTCA rules regarding soil are intended to apply to the vadose zone.

B.2.1.2 Groundwater Conditional Point of Compliance

The MTCA regulations favor permanent cleanup of groundwater contamination at the SPOC (throughout the site). If a permanent cleanup action is not selected for a site, then MTCA imposes additional requirements as described in WAC 173-340-360(2)(c)(ii).

A groundwater SPOC, as described in WAC 173-340-720(8)(b), would include all groundwater within the saturated zone beneath the PSC property and in any area affected by releases from the facility. However, under WAC 173-340-720(8)(c), Ecology may approve use of a CPOC if: a) it is not practicable to attain cleanup levels at the SPOC within a reasonable restoration timeframe, and b) all practicable methods of treatment have been used.

A CPOC is essentially a vertical surface extending downward from the water table and laterally so that it horizontally spans the groundwater area of interest. Groundwater cleanup levels would apply at this “point” and everywhere downgradient. Groundwater contamination upgradient of the CPOC, but within the site, would not require cleanup to achieve cleanup levels within a reasonable timeframe (as long as conditions in WAC 173-340-720(8)(c) are met).

A groundwater CPOC may be located either on the source property (e.g., at the property boundary) or beyond the property boundary. Requirements for establishing a groundwater CPOC beyond the property boundary are set forth in WAC 173-340-720(8)(d)(ii) for facilities near, but not abutting, surface water (such as PSC’s RCRA facility). The specific regulatory requirements for establishing an off-property groundwater CPOC include the following:

- It is not practicable to attain the SPOC within a reasonable restoration timeframe (WAC 173-340-720(8)(c));

- The CPOC shall be as close as practicable to the source of the release (WAC 173-340-720(8)(c));

- All practicable methods of treatment will be used in the cleanup throughout the entire zone of contamination (WAC 173-340-720(8)(c));

- The CPOC will not be located beyond the point or points where groundwater flows into surface water (WAC 173-340-720(8)(d)(ii));

- The CPOC will not be located beyond the extent of groundwater exceeding cleanup levels (WAC 173-340-720(8)(d)(ii));

- All known available and reasonable methods of treatment will be provided for the groundwater prior to being released to surface water (WAC 173-340-720(8)(d)(i));
- The discharge of affected groundwater to surface water will not result in violations of sediment quality values specified in WAC 173-204 (WAC 173-340-720(8)(d)(i));
- Appropriate monitoring will be conducted to assess the long-term performance of the selected cleanup action (WAC 173-340-720(8)(d)(i));
- All affected property owners between the source of contamination and the CPOC will agree to the CPOC location in writing (WAC 173-340-720(8)(d)(ii)); and
- A notification and solicitation of comments of a proposed CPOC will be mailed to natural resource trustees, the Washington State Department of Natural Resources, and the U.S. Army Corps of Engineers (WAC 173-340-720(8)(d)(i)).

The regulatory requirements above must be met in order to establish an off-property groundwater CPOC. All but the last two bullets in this list are technical requirements that were addressed in the PSC FS for remedial alternatives that incorporated a CPOC beyond the company's property boundary. The requirements specified in the last two bullets were not addressed by the FS; these requirements will instead be addressed after Ecology's finalization of the CAP.

An off-property groundwater CPOC was proposed by PSC in the FS, and for the purposes of the FS and this CAP was approved by Ecology (subject to PSC's ability to comply with all COPC requirements). POCs were defined in the FS for the upper saturated Outside Area zones comprising the water table, shallow, and intermediate depth intervals as well as for the deep aquifer. Due to the fully developed urban setting adjacent to the RCRA facility, a single, off-property CPOC for aquifers above the aquitard was defined and incorporated into the selected remedial alternative (please see Figure 15). Since the deep aquifer is separated from upper groundwater near the facility, the proposed POC for the deep aquifer is the SPOC.

Water Table, Shallow, and Intermediate Depth Intervals

As noted above, the CPOC must be located as close to the source area as practicable. The PSC source area has now been enclosed by a low-permeability barrier wall. The barrier wall is located very near the downgradient property boundary. PSC's FS documents provide a demonstration that it is not practicable to attain cleanup levels within a reasonable timeframe at a standard groundwater POC (i.e., in all groundwater, including groundwater behind the barrier wall). The location for the water table, shallow, and intermediate depth interval groundwater

CPOC was therefore selected immediately downgradient of the barrier wall. Groundwater compliance monitoring for this POC will be conducted here and downgradient. This location is consistent with the location-specific CPOC requirements cited in the MTCA regulations, as noted above.

PSC will obtain landowner approvals for the CPOC, and notify the government agencies, after finalization of the CAP (again, assuming it contains the proposed CPOC). The remaining requirements for establishing an off-property CPOC will be addressed during design of the selected cleanup action.

Deep Aquifer

A SPOC is established for the deep aquifer. However, it is not practicable to monitor deep groundwater quality immediately beneath the facility. This would require installing deep aquifer wells through the site cap and through the silt aquitard that separates contained groundwater behind the wall from the deep zone. The upper saturated zone beneath the facility has been substantially affected by releases of several different constituents, and DNAPL may be present based on the observed concentrations of COCs. Installation of deep aquifer monitoring wells beneath the facility could carry groundwater into the deep aquifer, potentially providing a migration pathway for COCs. Therefore, the monitoring location for estimating compliance with the SPOC for the deep aquifer will be located along the upper saturated zone CPOC. Deep groundwater measured at this point may not be representative of water quality further to the east, beneath the RCRA facility. It is anticipated, therefore, that in the future, to confirm that deep groundwater in this area has attained cleanup levels, monitoring wells will need to be installed behind the barrier wall. Ecology recommends that deep wells behind the barrier wall not be installed until that time when deep aquifer water, here or downgradient of the PSC property, is being considered for potential use (i.e., for a use that requires *extraction*). Ecology believes it unlikely that any such use of the deep zone will be planned in the foreseeable future.

B.2.2 Cleanup Levels

The cleanup levels presented in this section were developed and evaluated in the FS. They were discussed in Section 4 of the text and are listed in Tables 4 through 8.

B.2.2.1 Groundwater Cleanup Levels

The groundwater cleanup levels in the CAP for the water table, shallow, and intermediate depth intervals, plus the deep aquifer, are MTCA Method B groundwater cleanup levels. They are included in FS Tech Memo #1 and other PSC FS documents (Geomatrix, 2005, 2006a-c, 2007a,b; Pioneer, 2006). The groundwater cleanup levels presented in the tables in the CAP text are limited to those hazardous substances detected in groundwater since February 2004, after the HCIM was completed.

For groundwater depths less than or equal to 20 feet bgs (i.e., the “water table interval”), the cleanup level for each substance was selected by choosing the minimum of the following:

- Health-based concentrations associated with a Residential Inhalation Exposure Scenario (WAC 173-340-750; MTCA Method B equations 750-1 and 750-2). These are groundwater concentrations low enough to adequately protect indoor residents potentially inhaling air contaminated via the vapor intrusion migration pathway;

- Health-based concentrations associated with an Asian Pacific Islander (API) Fisher Exposure Scenario (MTCA Method B equations 730-1 and 730-2). These are groundwater concentrations low enough to protect humans eating fish caught from the Duwamish Waterway (this bullet and the four that follow are intended to establish concentrations in groundwater that will protect surface water quality in the Duwamish Waterway). The seafood intake rate was increased to 57 grams/day and the fish diet fraction was increased to one and the body weight was changed to 63 kilograms. These exposure parameters were recommended by the MTCA Science Advisory Board in a September 2006 memo entitled, "*Status of Science Advisory Board Review of Ecology’s Proposal to Establish a Site-Specific Fish Consumption Rate for the Asian Pacific Islander (API) Community Consuming Fish from Elliot Bay and the Duwamish River*";

- Ambient Water Quality Criteria (AWQC), based on human health consumption of organisms harvested from surface water (33 U.S.C. 1251 et seq., Federal Clean Water Act Section 304, National Recommended Water Quality Criteria, 2004);

- Ecological Risk Assessment Surface Water Screening Levels, protective of aquatic biota in surface water. These Levels were selected, in decreasing order of preference, from the following sources:

  - Washington State AWQC, Chapter 173-201A WAC,

  - Oak Ridge National Laboratory Surface Water Benchmarks (March 2005, http://www.esd.ornl.gov/programs/ecorisk/benchmark_reports.html and http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html),

  - AQUIRE Effects-Based Concentrations (March 2005, http://www.epa.gov/ecotox/), and
  - U.S. Geological Survey (USGS) Screening Values (1999, Selection Procedure and Salient Information for Volatile Organic Compounds Emphasized in Natural Water Quality);
- AWQC Freshwater and Marine Criteria Maximum Concentration, Criteria Continuous Concentration, and Organoleptic Effects (Federal Clean Water Act Section 304, National Recommended Water Quality Criteria, 2004);
- State of Washington Freshwater and Marine Acute and Chronic effects (WAC 173-201A); and
- MTCA Method A TPH cleanup levels (WAC 173-340 - Table 720-1).

For groundwater in the shallow and intermediate depth intervals (below the water table zone), the cleanup level for each substance was selected by choosing the minimum of these same levels, except for the concentrations associated with the first bullet (health-based concentrations associated with a Residential Inhalation Exposure Scenario). The vapor intrusion migration pathway is only a concern for the shallowest (water table) groundwater.

For the deep aquifer, the cleanup level for each constituent was selected by choosing the minimum of the concentrations considered for the shallow and intermediate depth intervals, plus the following:

- MTCA Method B cleanup criteria based on ingestion of groundwater (MTCA equations 720-1 and 720-2); and,
- Federal drinking water Maximum Contaminant Levels (MCLs).

Practical Quantitation Limit (PQL) Considerations under WAC 173-340-705(6)

For some substances, cleanup levels were revised upward to address analytical method limitations in accordance with the MTCA regulations (WAC 173-340-705(6)). In accordance with WAC 173-340-707, if the detection limit (PQL) for a substance is higher than the final groundwater cleanup level, the cleanup level is raised to the PQL level if:

- The PQL is no greater than 10 times the method detection limit (MDL); and
- The laboratory PQL is not higher than the EPA-established PQL.

PQLs were obtained from the current project laboratory, Washington State-certified Columbia Analytical Services (CAS) of Kelso, Washington. CAS performs low level and selective ion monitoring (SIM) for VOC, SVOC, and PCB analyses to attain PQLs below typical reporting limits. For some polycyclic aromatic hydrocarbons (PAHs), the CAS PQL was slightly higher than 10 times the MDL. In these cases, the value of 10 times the MDL was used as the PQL. Applicable analytical methods, MDLs, and PQLs (CAS and federal) used for adjusting the Method B groundwater cleanup levels are provided in Table B-1.

Total Risk Considerations Under WAC 173-340-705(4)

To ensure that the total risk and hazards present at the completion of cleanup do not exceed a risk greater than 10^{-5} or a hazard index of 1.0, cleanup levels for individual substances were calculated based on a risk factor of 10^{-6} and a hazard quotient of 0.1. This is further discussed in FS Tech Memo #1.

B.2.2.2 Soil Cleanup Levels

The cleanup level for each soil COC was selected by choosing the minimum of the following:

- MTCA Method C cleanup levels. These are Industrial Cleanup Levels, based on a Worker Exposure Scenario (MTCA equations 745-4, 745-5; and Method C Soil Cleanup Levels based on the Protection of Air, equations 750-1 and 750-2). The Method C equations were modified to calculate soil cleanup levels using a 10^{-6} cancer risk factor and hazard quotient of 0.1 for each substance and pathway;

- MTCA Method A Table Values for Industrial sites (Table 745-1); and

- Method B Soil-to-Groundwater Cleanup Levels (WAC 173-340-747(4)). The groundwater cleanup levels discussed above were used to calculate these soil cleanup levels protective of groundwater quality.

PQL and Background Considerations Under WAC 173-340-705(6) and WAC 173-340-709

To establish soil cleanup levels, the minimum risk-based cleanup levels derived above were compared to natural background levels and PQLs in accordance with the MTCA regulations (WAC 173-340-709 and WAC 173-340-705(6)). If necessary, the cleanup levels were modified so that they were no lower than natural background or PQLs. Natural background levels for metals were obtained from Natural Background Soil Metals Concentrations in

Washington State (Ecology, 1994) defined by Ecology for the Puget Sound area.[5] Cleanup levels that were below the defined Puget Sound natural background levels were adjusted up to the applicable natural background level in accordance with the limitations set forth in WAC 173-340-706(6).

Applicable PQLs were established for soil in the same manner used for groundwater, as described above. Applicable analytical methods, MDLs, and PQLs (CAS and federal) used for establishing the Method C soil cleanup levels are provided in Table B-2.

B.3 REMEDIATION LEVELS

For Outside Area groundwater COCs expected to reach the Duwamish Waterway at concentrations above PQLs, surface water-based cleanup levels were developed that would apply at the CPOC and points downgradient. However, reaching the Waterway at a concentration above the PQL is not the same as reaching surface water at a concentration above surface water cleanup levels. So Outside Area groundwater COCs capable of reaching the Waterway were grouped into: a) those that may reach the Waterway at concentrations above surface water cleanup levels and b) those that reach it, but at concentrations below cleanup levels. It is the former group of COCs that poses the most concern for surface water quality.

While the ultimate goal of corrective action is to attain cleanup levels at the CPOC and points downgradient, some contaminant concentrations above cleanup levels pose a greater risk than others. The RL concept is used, then, as a *dividing line* to separate those COC concentrations unlikely to pose a threat to surface water quality from those which do, or could. The latter are concentrations that typically merit more aggressive and urgent remediation. While COCs with concentrations below the RL at the CPOC may be good candidates for a *natural attenuation* remedy, COCs with concentrations exceeding the RL warrant more aggressive action.

PSC remediation levels (RLs) are groundwater concentrations that are expected to attenuate to cleanup levels protective of surface water at the point of discharge to the Duwamish Waterway.

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[5] The Puget Sound natural background values were calculated as the 90th percentile value using Ecology's MTCAStat program on a sample set of n = 45. WAC 173-340-709(2) specifies that for the purposes of defining background concentrations, samples shall be collected from areas that have not been influenced by releases from the site and, in the case of natural background, concentrations that have not been influenced by releases from other localized human activities. Given the industrial and urban setting of the Area addressed in the Site-Wide Feasibility Study, Ecology-determined regional natural background levels were considered more reliable and appropriate than background calculations developed using data collected in the Georgetown area and the background calculations specified under WAC 173-340-709.

They are established at the proposed CPOC. As an example: vinyl chloride is present in groundwater in the Outside Area at concentrations greater than surface water cleanup levels. Fate and transport modeling was therefore used to estimate the degree of vinyl chloride concentration attenuation between the COPC (a location at the far eastern end of the Outside Area) and the point where groundwater discharges to the river. Then, if the amount of predicted attenuation was 100 times, and the vinyl chloride surface water cleanup level was, say, 1.0 microgram per liter (µg/l), the remediation level, or concentration that could be tolerated at CPOC, would be 100 µg/l.

RLs were developed for organic COCs by using the BIOCHLOR model (EPA, 2002) to estimate the degree the COCs would attenuate between the CPOC and the Duwamish River. RLs were not established for inorganic COCs, as these are not expected to reach the Duwamish Waterway at concentrations greater than surface water protection criteria for any of the three depth intervals or the deep aquifer.

The RLs utilized in the FS are described below.

Water Table Interval – TCE and vinyl chloride RLs were derived. Because vinyl chloride is a breakdown product of tetrachloroethene (PCE) – via several intermediate steps -- RLs were also derived for PCE and cis-1,2-dichloroethene (cis-1,2-DCE).[6]

Note: RLs are groundwater concentrations protective of surface water only; so for the water table depth interval, for example, they are not necessarily protective of the indoor air (vapor intrusion) pathway.

Shallow Interval – Under existing conditions, 1,4-dioxane is not expected to biodegrade significantly. Conservative natural attenuation modeling therefore assumed no degradation and only dispersion and dilution in deriving the RL for 1,4-dioxane.

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[6] RL derivation is most sensitive to the biodegradation half-life assumed in the modeling. This is particularly true for vinyl chloride. Generally speaking, increasing the biodegradation half-lives used by the model by a factor of 3 should be highly conservative. However, increasing vinyl chloride's half-life by this factor results in a half-life (2.46 years) that is still within the range of expected (based on existing biodegradation literature) vinyl chloride biodegradation rates under conditions that exist in the cleanup area. As a result, the RLs calculated using a vinyl chloride half-life increased by a factor of 3 were selected as reasonably conservative RLs that should be protective of the Duwamish Waterway.

Intermediate Interval – An RL was also developed for 1,4-dioxane in the intermediate depth interval. However, groundwater monitoring conducted since the modeling performed in Technical Memorandum No. 1 (Geomatrix, 2006a) has shown a sharp decline in 1,4-dioxane concentrations in the downgradient plume. PSC's updated dioxane modeling, provided to Ecology in August 2007 (Geomatrix, 2007d), indicates that cleanup levels should not be exceeded adjacent to the waterway.

Deep Aquifer – Deep aquifer COC concentrations were not sufficiently elevated to merit development of RLs.

ATTACHMENTS:	Table B-1	Groundwater Practical Quantitation Limits
	Table B-2	Soil Practical Quantitation Limits

TABLE B-1

GROUNDWATER PRACTICAL QUANTITATION LIMITS

PSC Georgetown Facility
Seattle, Washington

Constituent[1]	Analytical Method[2]	CAS PQL[3] (µg/L)	CAS Method Detection Limit[4] (µg/L)	Federal Reporting Limit[5] (µg/L)	Applicable PQL[6] (µg/L)
Arsenic	1640/200.8	0.03/0.5	0.2	--[7]	0.03
Barium	6000/7000 series	0.05	0.03	--	0.05
Copper	6000/7000 series	0.1	0.03	--	0.1
Cyanide	9010/9012	10	3	20	10
Chromium	6000/7000 series	0.2	0.06	--	0.2
Hexavalent Chromium	SM3500-CR	10	0.02	--	0.2
Iron	6000/7000 series	20	20	--	20
Lead	6000/7000 series	0.02	0.009	--	0.02
Manganese	6000/7000 series	0.05	0.02	--	0.05
Nickel	6000/7000 series	0.2	0.06	--	0.2
Selenium	6000/7000 series	1	0.2	--	1
Silver	6000/7000 series	0.02	0.009	--	0.02
Vanadium	6000/7000 series	0.2	0.03	--	0.2
Zinc	6000/7000 series	0.5	0.3	--	0.5
Diesel range hydrocarbons	NWTPH-Dx	100	19	--	100
Gasoline range hydrocarbons	NWTPH-Gx	250	13	--	130
PCB Aroclor 1016	8082 low level	0.005	0.0031	0.005	0.005
PCB Aroclor 1232	8082 low level	0.005	0.0031	0.005	0.005
1,4-Dichlorobenzene	8270 low level	0.2	0.0133	10	0.133
1,4-Dioxane	modified 8270	0.1	--	--	0.1
2,4-Dimethylphenol	8270 low level	2	0.318	10	2
2-Methylphenol	8270 low level	0.5	0.0594	10	0.5
2-Methylnaphthalene	8270 low level	0.02	0.00268	--	0.02
4-Methylphenol	8270 low level	0.5	0.0508	--	0.5
Benzo(a)anthracene	8270 SIM PAH	0.02	0.0021	10	0.02
Benzo(b)fluoranthene	8270 SIM PAH	0.02	0.00194	10	0.0194
Benzoic Acid	8270 low level	5	1.71	--	5
Benzo(k)fluoranthene	8270 SIM PAH	0.02	0.00134	10	0.0134
Bis(2-ethylhexyl) phthalate	8270 low level	2	0.27	10	2
C10-c12 (EPH) Aromatics	NWTPH EPH	50	--	--	50
C8-c10 (EPH) Aromatics	NWTPH EPH	50	--	--	50
C8-c10 (VPH) Aromatics	NWTPH VPH	50	--	--	50
C8-c10 (EPH) Aliphatics	NWTPH EPH	50	--	--	50
Ethane	RSK 175	0.5	0.38	--	0.5
Ethene	RSK 175	1.5	0.55	--	1.5
Methane	RSK 175	0.5	0.3	--	0.5
Chrysene	8270 SIM PAH	0.02	0.00124	10	0.0124
Dibenzo(a,h)anthracene	8270 SIM PAH	0.02	0.00162	10	0.0162
Indeno(1,2,3-cd)pyrene	8270 SIM PAH	0.02	0.00208	10	0.02
Methylphenol	8270 low level	0.5	0.0594	10	0.5
Phenol	8270 low level	0.5	0.0196	--	0.196
Pentachlorophenol	8270 low level	1	0.0283	50	0.283
Chlorobenzene	8260	0.5	0.0933	1	0.5
1,1,1-Trichloroethane	8260	0.5	0.113	1	0.5
1,1,2-Trichlorotrifluoroethane	8260	0.5	0.13	1	0.5
1,1-Dichloroethane	8260	0.5	0.0906	1	0.5
1,1-Dichloroethylene	8260 SIM	0.02	0.0047	1	0.02

TABLE B-1

GROUNDWATER PRACTICAL QUANTITATION LIMITS

PSC Georgetown Facility
Seattle, Washington

Constituent[1]	Analytical Method[2]	CAS PQL[3] (µg/L)	CAS Method Detection Limit[4] (µg/L)	Federal Reporting Limit[5] (µg/L)	Applicable PQL[6] (µg/L)
1,2-Dichlorobenzene	8260	0.5	0.088	1	0.5
1,2-Dichloroethane	8260 SIM	0.2	0.0045	1	0.045
1-Methyl naphthalene	8270 SIM PAH	0.02	0.0025	1	0.02
2-Chloroethylvinyl ether	8260	5	0.333	--	3.33
2-Hexanone	8260	20	3.96	--	20
Benzene	8260	0.5	0.105	1	0.5
Carbon Disulfide	8260	0.5	0.159	--	0.5
Carbon Tetrachloride	8260	0.5	0.128	--	0.5
Chloroethane	8260	0.5	0.226	1	0.5
Chloroform	8260	0.5	0.0958	1	0.5
cis-1,2-Dichloroethylene	8260	0.5	0.116	1	0.5
Cumene	8260	2	0.068	--	0.68
Dichlorodifluoromethane	8260	0.5	0.166	--	0.5
Ethylbenzene	8260	0.5	0.13	1	0.5
Methylene Chloride	8260	2	0.193	1	1
Methyl Isobutyl Ketone	8260	20	1.8	--	18
Naphthalene	8260	2	0.285	1	1
n-Hexane	8260	1	0.18	1	1
Styrene	8260	0.5	0.0943	--	0.5
Tetrachloroethylene	8260	0.02	0.0035	1	0.02
Toluene	8260	0.5	0.0975	1	0.5
trans-1,2-Dichloroethylene	8260	0.5	0.143	1	0.5
Trichloroethene	8260 SIM	0.02	0.005	1	0.02
Vinyl Chloride	8260 SIM	0.02	0.0081	1	0.02
Xylene (total)	8260	0.5	0.0785	1	0.5
1,2,4-Trimethylbenzene	8260	2	0.141	1	1
1,3,5-Trimethylbenzene	8260	2	0.121	1	1
p-Isopropyltoluene (4-isopropyltoluene)	8260	2	0.128	1	1
Propylbenzene	8260	2	0.098	1	0.98
sec-Butylbenzene	8260	2	0.127	1	1

Notes:

1. EPH = Extractable petroleum hydrocarbons;
   VPH = Volatile petroleum hydrocarbons.
2. NWTPH-Dx = Northwest total petroleum hydrocarbons, diesel range;
   NWTPH-Gx = Northwest total petroleum hydrocarbons, gasoline range;
   SIM PAH = selective ion monitoring, polycyclic aromatic hydrocarbons.
3. PQL = Practical quantitation limit in micrograms per liter (µg/L) as reported by Columbia Analytical Services (CAS), Kelso, Washington (project laboratory).
4. Method detection limit as reported by CAS.
5. Federal Reporting Limits from U.S. Environmental Protection Agency SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (www.epa.gov/epaoswer/hazwaste/test/6_series.htm).
6. CAS PQL selected as the Applicable PQL unless the CAS PQL was less than 10 times the CAS Method Detection Limi (MDL), in which case 10 times the MDL value is considered the Applicable PQL [per WAC 173-340-707(a)], or if the CAS PQL was greater than the Federal Reporting Limit, then the Federal Reporting Limit was selected as the Applicable PQL [WAC 173-340-707(b)].
7. -- = Not established or specified.

TABLE B-2

SOIL PRACTICAL QUANTITATION LIMITS

PSC Georgetown Facility
Seattle, Washington

Concentrations in milligrams per kilogram (mg/kg)

Constituent	Analytical Method[1]	CAS PQL[2] (mg/kg)	CAS Method Detection Limit[3] (mg/kg)	Federal Reporting Limit[4] (mg/kg)	Applicable PQL[5] (mg/kg)
1,1,1-Trichloroethane	8260	0.005	0.00057	0.005	0.005
1,1-Dichloroethane	8260	0.005	0.00078	0.005	0.005
1,1-Dichloroethene	8260	0.005	0.00069	0.005	0.005
1,2,4-Trichlorobenzene	8260	0.02	0.00077	0.005	0.005
1,2,4-Trimethylbenzene	8260	0.02	0.00082	0.005	0.005
1,2-Dichlorobenzene	8260	0.005	0.00065	0.005	0.005
1,2-Dichloroethane	8260	0.005	0.00067	0.005	0.005
1,3,5-Trimethylbenzene	8260	0.02	0.00082	0.005	0.005
2,4-Dimethylphenol	8270 low level	0.05	0.0055	0.66	0.05
2-Hexanone	8260	0.02	0.0061	--[6]	0.02
2-Methylnaphthalene	8270 SIM PAH	0.005	0.00034	0.66	0.0034
2-Methylphenol	8270 low level	0.01	0.0034	0.66	0.01
4-Methylphenol	8270 low level	0.01	0.0029	0.66	0.01
Acetone	8260	0.02	0.01	0.005	0.005
Aroclor 1016/1242	8270 low level	0.01	0.0018	3.8	0.01
Aroclor 1254	8270 low level	0.01	0.0018	3.8	0.01
Aroclor 1260	8270 low level	0.01	0.0018	3.8	0.01
Arsenic	200.8	0.5	0.07	--	0.5
Barium	6020	0.05	0.03	--	0.05
Benzene	8260	0.005	0.00079	0.005	0.005
Benzo(a)anthracene	8270 SIM PAH	0.005	0.00016	0.66	0.0016
Benzo(a)pyrene	8270 SIM PAH	0.005	0.00022	0.66	0.0022
Benzo(b)fluoranthene	8270 SIM PAH	0.005	0.00048	0.66	0.0048
Benzo(ghi)perylene	8270 SIM PAH	0.005	0.00023	0.66	0.0023
Benzo(k)fluoranthene	8270 SIM PAH	0.005	0.00033	0.66	0.0033
Benzoic acid	8270 low level	0.2	0.096	3.3	0.2
Bis(2-ethylhexyl) phthalate	8270 low level	0.2	0.0017	--	0.017
Cadmium (food)	6020	0.05	0.007	--	0.05
Chloroethane	8260	0.005	0.00078	0.005	0.005
Chloroform	8260	0.005	0.00057	0.005	0.005
Chromium	6020	0.2	0.04	--	0.2
Chrysene	8270 SIM PAH	0.005	0.00041	--	0.0041
cis-1,2-Dichloroethene	8260	0.005	0.00083	0.005	0.005
cis-1,3-Dichloropropene	8260	0.005	0.00076	0.005	0.005
Copper	6020	0.1	0.02	--	0.1
Cumene	8260	0.02	0.00068	0.005	0.005
Cyanide	335.2/9012A	0.1	0.03	--	0.1
Dibenzo(a,h)anthracene	8270 SIM PAH	0.005	0.00026	0.66	0.0026
Dibenzofuran	8270 SIM PAH	0.005	0.00017	0.66	0.0017
Diesel range hydrocarbons	NWTPH-Dx	25	3.4	--	25
Di-n-butyl phthalate	8270 low level	0.01	0.0026	--	0.01
Di-n-octyl-phthalate	8270 low level	0.01	0.0012	0.66	0.01
Ethylbenzene	8260	0.005	0.00057	0.005	0.005
Fluoranthene	8270 SIM PAH	0.005	0.00034	0.66	0.0034

TABLE B-2

SOIL PRACTICAL QUANTITATION LIMITS

PSC Georgetown Facility
Seattle, Washington

Concentrations in milligrams per kilogram (mg/kg)

Constituent	Analytical Method[1]	CAS PQL[2] (mg/kg)	CAS Method Detection Limit[3] (mg/kg)	Federal Reporting Limit[4] (mg/kg)	Applicable PQL[5] (mg/kg)
Gasoline range hydrocarbons	NWTPH-Gx	5	1	--	5
Indeno(1,2,3-cd)pyrene	8270 SIM PAH	0.005	0.00024	0.66	0.0024
Lead	6020	0.05	0.02	--	0.05
Lube oil range hydrocarbons	NWTPH-Dx	25	3.4	--	25
Mercury	7471A	0.02	0.008	--	0.02
Methyl isobutyl ketone (MIBK)	8260	0.02	0.0055	0.005	0.005
Methylene chloride	8260	0.01	0.00096	0.005	0.005
Naphthalene	8260	0.02	0.00089	0.005	0.005
n-Butylbenzene	8260	0.02	0.00075	0.005	0.005
Nickel	6020	0.2	0.04	--	0.2
Pentachlorophenol	8270 SIM PAH	0.2	0.015	3.3	0.15
Phenanthrene	8270 SIM PAH	0.005	0.00033	0.66	0.0033
Phenol	8270 low level	0.03	0.0019	0.66	0.019
p-Isopropyltoluene	8260	0.02	0.00072	0.005	0.005
Propylbenzene	8260	0.02	0.00072	0.005	0.005
Pyrene	8270 SIM PAH	0.005	0.00036	0.005	0.0036
sec-Butylbenzene	8260	0.02	0.00074	0.005	0.005
Selenium	6020	0.1	0.02	--	0.1
Silver	6020	0.02	0.003	--	0.02
Styrene	8260	0.005	0.00073	0.005	0.005
Tetrachloroethene	8260	0.005	0.00031	0.005	0.0031
Toluene	8260	0.005	0.00084	0.005	0.005
trans-1,2-Dichloroethylene	8260	0.005	0.00073	0.005	0.005
trans-1,3-Dichloropropene	8260	0.005	0.0006	0.005	0.005
Trichloroethene	8260	0.005	0.00028	0.005	0.0028
Trichlorofluoromethane	8260	0.005	0.00073	0.005	0.005
Vinyl chloride	8260	0.005	0.00062	0.005	0.005
Xylenes (Total)	8260	0.005	0.0015	0.005	0.005
Zinc	6020	0.5	0.2	--	0.5

Notes:

1. NWTPH-Dx = Northwest total petroleum hydrocarbons, diesel range;
   NWTPH-Gx = Northwest totalpetroleum hydrocarbons, gasoline range;
   SIM PAH = selective ion monitoring, polycyclic aromatic hydrocarbons.
2. PQL = Practical quantitation limit in milligrams per kilogram (mg/kg) as reported by Columbia Analytical Services (CAS), Kelso, Washington (project laboratory).
3. Method detection limit as reported by CAS.
4. Federal Reporting Limits from U.S. Environmental Protection Agency SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (www.epa.gov/epaoswer/hazwaste/test/6_series.htm).
5. CAS PQL selected as the Applicable PQL unless the CAS PQL was less than 10 times the CAS Method Detection Limit (MDL), in which case 10 times the MDL value is considered the Applicable PQL; or if the CAS PQL was greater than the Federal Reporting Limit, then the Federal Reporting Limit was selected as the Applicable PQL.
6. -- = Not established.

APPENDIX C

Remedial Alternatives Evaluated in the FS for the HCIM Area

APPENDIX C

REMEDIAL ALTERNATIVES EVALUATED IN THE FS FOR THE HCIM AREA

The area addressed by the CAP includes the properties currently owned by PSC (the facility and the adjacent TASCO property), properties adjacent to the PSC properties that were affected by releases from the facility (Union Pacific Rail Road [UPRR] Argo Yard, Aronson, and SAD properties), and the contiguous areas affected by releases from the facility extending downgradient (west) to Fourth Avenue South. The **HCIM Area** is a part of this larger east-of-4th area, and includes the contaminated soils and groundwater behind the subsurface barrier wall.

Sections C.1 through C.6 below describe the six HCIM Area cleanup options evaluated in PSC's FS Technical Memorandum #5. They are, in effect, a summary of that document.

C.1 ALTERNATIVE HA-1 – ACTIVE HYDRAULIC CONTAINMENT

Alternative HA-1 relies on containment and monitored natural attenuation (MNA) to address soil and groundwater impacts within the HCIM Area. Alternative HA-1 includes the following elements:

- The existing barrier wall, installed as part of the HCIM, isolating and enclosing near-facility impacted soil and groundwater;
- The existing HCIM groundwater recovery and pretreatment system;
- Surface cap/cover, most of which is already in place;
- The existing groundwater monitoring wells and a revised monitoring program; and
- Institutional controls.

This alternative incorporates the existing HCIM and includes capping and institutional controls to contain contamination and block potential exposure pathways.

MNA is a proven technology that has been effective in reducing concentrations of chlorinated solvents and other COCs in groundwater when appropriate conditions are present. This process relies on the attenuation of soil and groundwater constituents by natural processes, including biodegradation, abiotic degradation, adsorption, and dispersion. Due to the passive nature of this remediation technology, it can be readily implemented with a minimum of administrative issues, such as permitting or arranging for access permissions. Since MNA is generally noninvasive, it can be readily implemented within an urban environment.

The existing subsurface barrier wall would be maintained intact under remedial alternative HA-1. The barrier wall completely encloses subsurface soils and groundwater within the HCIM Area down to the depth of the silt aquitard, and has been proven effective in isolating contaminated groundwater beneath PSC's property, east of Denver Ave. S. Programs and systems for monitoring and inspecting the barrier wall to maintain its effectiveness have been established and proven effective. The existing barrier wall has a very low permeability (less than 10^{-8} cm/sec).

The existing groundwater recovery and pretreatment system, which consists of two extraction wells, an air stripper, and associated pumps and controls, has also been incorporated into this remedial alternative. Groundwater withdrawn for the hydraulic control is treated and discharged to a POTW under a permit issued by King County. The system has reliably maintained an inward hydraulic gradient and has met regulatory standards for treated groundwater quality and air emissions since it began operation (Geomatrix, 2007c). Programs and systems have been established for operation, maintenance, inspection, and monitoring of the groundwater recovery and pretreatment system. Under this remedial alternative, an inward hydraulic gradient would continue to be maintained across the barrier wall.

Alternative HA-1 would supplement the existing microsilica concrete and asphalt caps that currently cover most of the HCIM Area with new capping placed over currently uncapped areas. The new cap would consist of a minimum thickness of 3 inches of asphalt to provide a continuous, low-permeability cover. The HCIM Area cap serves as a barrier to prevent direct contact with impacted soil, and also prevents erosion and runoff of impacted soil. While the surface cover is not intended as a complete barrier to surface water infiltration and recharge, the cover would promote runoff and limit infiltration of surface water within the HCIM Area. The cap would be regularly inspected and maintained to ensure it effectively provides an engineered barrier and limits infiltration.

Groundwater monitoring data indicate that ongoing natural biodegradation of chlorinated solvents within the HCIM Area will reduce chlorinated COC concentrations within the water table, shallow, and intermediate depth intervals. Groundwater samples collected from the intermediate depth interval during the RI indicate that *Dehalococcoides* microorganisms are present in HCIM Area groundwater. These organisms are capable of degrading vinyl chloride to ethene (He et al., 2003).

Prior to installation of the barrier wall, anaerobic biodegradation was occurring within the HCIM Area primarily as a result of the reducing conditions in the source and plume areas brought about by the mass of carbon-based COCs. Groundwater entering the facility from upgradient was oxidation/reduction (redox) neutral, but conditions varied between reducing and oxygenated conditions. Since the wall has been installed, very little fresh oxygenated water is able to enter the system and high concentrations of hydrocarbons and solvents in the source areas rapidly use up any oxygen remaining. This situation should result in favorable conditions for natural anaerobic degradation of VOCs and some SVOCs.

DNAPL that is suspected to be present in the HCIM Area will act as a continuing source of groundwater contamination and will likely preclude the attainment of cleanup levels for chlorinated VOCs for the foreseeable future. In addition, some other COCs present in HCIM Area groundwater (metals, for example) are not expected to naturally attenuate to any significant degree.

Institutional controls would be required to ensure that the alternative is fully protective of human health. The institutional controls included in this alternative are listed below:

- Prohibit use of groundwater beneath the HCIM Area for any purpose.
- Require use of appropriate personal protective equipment and compliance with the hazardous waste operations and emergency response (HAZWOPER) requirements specified in 29 CFR 1910.120 for all subsurface work conducted within the HCIM Area.
- Require notification of future property owners that recovered soil or groundwater from the HCIM Area may be required to be managed in accordance with the requirements of the Washington Dangerous Waste Rules (WAC 173-303).
- Require installation and operation of appropriate engineering controls to limit the entry and accumulation of soil gas within any building present or constructed over any portion of the HCIM Area.
- Require inspection and maintenance of the cap covering the HCIM Area, and require any potential future site construction or development to maintain the continuity and effectiveness of the cap.

- Require operation, maintenance, inspection, monitoring, and expeditious repair (if necessary) of the existing HCIM components (barrier wall recovery wells, groundwater extraction and pretreatment system, instruments and controls, and monitoring wells) in accordance with the existing operation, monitoring, and maintenance plan.

These institutional controls would be enforceable conditions incorporated into the deed for the properties either partially or totally contained within the HCIM Area. In addition, PSC would provide financial assurance for the continued monitoring, maintenance, and repair of the HCIM barrier wall, groundwater recovery and pretreatment system, and cap. Institutional controls would remain in place until soil and groundwater cleanup levels were attained within the HCIM Area. Since for some contaminants there is no expected date by which cleanup levels will be attained, the controls will essentially be required forever.

C.2 ALTERNATIVE HA-2 – CONTAINMENT AND ENHANCED ANAEROBIC BIOREMEDIATION

Remedial Alternative HA-2 incorporates all of the components of Alternative HA-1 and adds anaerobic in situ biostimulation (ISB) to enhance and accelerate biodegradation of chlorinated VOCs in groundwater. Alternative HA-2 includes the following elements:

- The existing barrier wall isolating and enclosing near-facility impacted soil and groundwater;
- The existing groundwater recovery and pretreatment system;
- Surface cover;
- Electron donor injection into affected HCIM Area groundwater;
- The existing groundwater monitoring wells and a revised monitoring program; and
- Institutional controls.

Enhanced anaerobic bioremediation (ISB) would be conducted in an effort to reduce the mass of DNAPL suspected to be present in two general areas within the HCIM Area, to reduce the mass of dissolved DNAPL constituents, and to reduce the time required to achieve groundwater cleanup levels for contaminants anaerobically degradable. COC concentrations in groundwater at two locations within the HCIM Area are consistent with a trail of DNAPL ganglia present from the water table interval to the Silt Aquitard. An ISB system would be installed to enhance and accelerate anaerobic biological degradation of chlorinated VOCs that is occurring within the HCIM Area. As noted in the final RI Report, monitoring conducted within the HCIM Area has positively identified ethene, ethane, and *Dehalococcoides* bacteria in groundwater, confirming that factors necessary for biodegradation of chlorinated VOCs are present. ISB would increase the organic carbon content in the treatment zone pore space by adding carbohydrate and distributing it throughout the target area. Excess organic carbon could be used as an electron donor by existing subsurface bacteria to accelerate ongoing biodegradation of TCE, cis-1,2-DCE, and VC to ethene. The technical literature indicates that enhanced biodegradation has been effective at reducing VOC concentrations, even in source areas where the DNAPL is present as ganglia (as suspected within the HCIM Area).

As with all technologies evaluated as part of the FS, using ISB to reduce the concentration of some COCs within the intermediate interval (interbedded silts and sands) all the way to cleanup levels within a reasonable timeframe is not considered likely. No remediation approach, short of excavating the entire site down to the aquitard, is expected capable of attaining cleanup levels in the intermediate interval within a reasonable timeframe.

However, groundwater COCs at depths greater than 50 feet are less of a concern than those at shallower depths, since this portion of the aquifer has low permeability. If the wall were to be breached and groundwater were to escape into the downgradient area, COC migration at such depths would be relatively slow. Many VOCs at this depth might not even reach the Duwamish Waterway. In addition, vapor intrusion is not a pathway for COCs at this depth.

HA-2's enhanced bioremediation will therefore target known source areas in the shallow and water table intervals down to a depth of approximately 50 feet. In the shallower intervals (shallow and water table intervals), some COC concentrations exceed cleanup levels, although some remediation levels (RLs) appear to have been met for most wall failure scenarios.[1] Monitoring data are not available for all source areas within the HCIM Area, and therefore it is possible that RLs are not being achieved in all areas behind the wall.

Several proven electron donor materials are readily available for ISB, including molasses, sodium lactate, and emulsified vegetable oil. The specific electron donor that would be used for each groundwater interval would be determined during implementation; the delivery system

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[1] In their FS technical memoranda PSC attempted to assess the consequences of various wall failure scenarios. This is admittedly a difficult task since it is unknown at this time whether the wall will ever fail to any significant degree, and if so, how and where it will fail. Under most of the scenarios examined, however, it did not appear that significant wall failures would result in a threat to surface water quality in the Duwamish River.

design can readily accommodate any liquid electron donor material. For the purpose of estimating the cost of this alternative in the FS, it was assumed that only the shallower zones (water table and shallow intervals) would be treated, and that molasses would be used as the electron donor. Groundwater flow within the HCIM Area is significantly influenced by the barrier wall, and it is anticipated that groundwater flow gradients are extremely limited; therefore, loss of electron donor would occur primarily due to biodegradation. It is anticipated that multiple electron donor injections would be necessary.

The conceptual design for Alternative HA-2 includes the installation of a recirculation well system within the HCIM Area to uniformly distribute the substrate within the water table and shallow depth intervals. A total of 10 extraction wells and 22 injection wells would be installed. Electron donor would be injected into a targeted treatment zone consisting of one extraction well and the four nearest injection wells. Injection within a targeted treatment zone would be accomplished by withdrawing water from the central extraction well, mixing an electron donor with the extracted groundwater, and re-injecting the mixture through the four surrounding injection wells spaced about 50 feet apart. Groundwater recirculation would continue until the electron donor is detected in the extracted groundwater. Two nested wells would be located at each injection well and extraction well location. Each well would be constructed with 40 feet of screen. The shallow injection/extraction wells would be installed to a depth of approximately 50 feet bgs to treat the water table and shallow groundwater intervals.

Repeat injections would be conducted periodically to maintain a high level of biological activity and effective reductive dechlorination of chlorinated VOCs and breakdown products. It was assumed that two injections would be performed each year over a 4-year period, for a total of eight injection events

Although enhanced anaerobic bioremediation would reduce the mass of DNAPL within the treatment areas, it is unlikely to remove all DNAPL ganglia present, and it would have limited effect on DNAPL within the intermediate interval. In addition, subsurface heterogeneities, preferential flow paths, and poor mixing in the subsurface may result in inefficient treatment. The contaminant mass in the subsurface is unknown. It is therefore difficult to estimate the time that would be required for degradable COC concentrations in groundwater within the HCIM Area to reach cleanup levels – if these levels would be reached.

Administrative institutional controls would be incorporated into the alternative to ensure that human health and the environment are adequately protected by Alternative HA-2. These administrative controls would be the same as described for Alternative HA-1 in Section C.1.

C.3 ALTERNATIVE HA-3 – CONTAINMENT, DEWATERING, SVE, AND ENHANCED ANAEROBIC BIOREMEDIATION

Remedial Alternative HA-3 incorporates all of the components of Alternative HA-2. But, this alternative additionally supplements bioremediation through implementation of partial dewatering and a soil vapor extraction (SVE) system to treat elevated concentrations of VOCs and residual DNAPL that may be present in the vadose zone and the dewatered soil column. Alternative HA-3 would accelerate removal of residual DNAPL and/or high concentrations of VOCs that may be present within the upper portion of the shallow interval and the water table interval in known source areas.

The following elements are included in Alternative HA-3:

- The existing barrier wall isolating and enclosing near-facility impacted soil and groundwater;
- An upgraded groundwater recovery and pretreatment system, with greater capacity than the existing system (so that dewatering could be implemented);
- Surface cap/cover;
- Partial dewatering followed by SVE;
- Electron donor injection into affected HCIM Area groundwater;
- The existing groundwater monitoring wells and a revised monitoring program; and
- Institutional controls.

Alternative HA-3 would be implemented in a phased approach. The first phase would include construction of caps over currently uncapped areas. Accelerated groundwater extraction would be conducted in the three SVE treatment areas to lower the water table approximately 10 to 15 feet and vertically extend the effective zone of the vapor extraction wells. Groundwater modeling indicates that in order to lower the water table an additional 10 to 15 feet in the HCIM Area, groundwater extraction would need to be maintained at a total pumping rate of between 30 and 50 gallons per minute (gpm). The conceptual design of the groundwater extraction system includes one new extraction well installed in each SVE treatment area (three wells total), plus the two existing extraction wells, for a total of five wells. In addition, the existing HCIM groundwater recovery system would be modified to increase the treatment capacity to accommodate the additional dewatering groundwater

The existing treatment system for the HCIM groundwater extraction system does not have sufficient capacity to treat the additional groundwater (approximately 30 to 50 gpm) that would be extracted under Alternative HA-3. In addition, the extracted groundwater may contain elevated concentrations of metals. Therefore, the extracted groundwater would be treated by a separate low-profile air stripper to remove VOCs, followed by chemical dosing/precipitation to remove metals prior to discharge to the King County POTW. The King County discharge permit would be modified for the period of the dewatering to allow this higher discharge volume. For FS estimating purposes, it was assumed that dewatering to this depth and then extracting soil vapor would be completed within 4 years; however, the actual duration of vapor extraction could be different, as appropriate, to effectively remove contaminant mass.

Based on soil sampling results presented in the RI, SVE would be implemented in three areas on the PSC facility and adjacent portions of the SAD property. A total of six vapor extraction wells would be installed to a depth of approximately 25 feet bgs and would be constructed with 4-inch diameter Schedule 40 polyvinyl chloride (PVC) with 20 feet of 0.10-inch slotted well screen. The annulus around the well screen and casing would be filled with filter sand to approximately 1 foot above the screen and sealed with approximately 1 foot of hydrated bentonite pellets above the filter sand. The remaining annulus around the well casing would then be filled to grade with concrete. Each SVE well would be connected to a flow-control manifold to allow flow from each SVE well to be independently adjusted as necessary to control the zone influenced by the SVE system. Except for a small area that would be covered with asphalt, the entire HCIM Area is currently capped with a combination of microsilica concrete and asphalt. Because the duration of the SVE is expected to be relatively short, all system piping would be routed above ground to minimize disturbance to the existing cap system.

A regenerative blower with a capacity of 400 cubic feet per minute (cfm) would be used to induce a vacuum on the vapor extraction wells and direct the recovered vapor stream to the emission control system. A vacuum of approximately 25 inches of water would be induced on each SVE well. Based on operational data obtained from the previous SVE system at the site, it is anticipated that the radius of influence of each vapor extraction well would be approximately 50 to 75 feet at this applied vacuum, and the vapor flow rate from each well would be approximately 50 cfm.

Emission controls for the extracted vapor stream would be selected based on initial system testing following installation of the SVE wells. During the initial test period, the extracted vapor stream would be treated with granular activated carbon (GAC) prior to discharge to the atmosphere. It was assumed that VOC concentrations in the extracted vapor stream would require treatment with a rented catalytic oxidizer unit for 1 year. The extracted vapor stream would then be treated with granular activated carbon units for the life of the system. It was assumed that the system would operate for a period of 4 years. The actual operational period of the system would likely be determined based on VOC concentrations in the extracted vapor streams and whether the system has reached a point of diminishing returns.

Operation of the SVE system would be monitored by collection of vapor samples from the extracted vapor stream and individual SVE wells, as well as periodic measurements of VOC concentrations in the extracted vapor stream using a photoionization detector (PID). In addition, collection of vapor samples downstream of the emission controls system would likely be required as a condition of the air permit for the system. A Notice of Construction would be prepared and submitted to the Puget Sound Clean Air Agency (PSCAA) prior to construction of the SVE system.

At the completion of the SVE operation, anaerobic groundwater bioremediation would be conducted within the two suspected DNAPL areas, as outlined under Alternative HA-2. Groundwater levels within the HCIM Area would be allowed to recover to pre-SVE conditions prior to initiation of anaerobic bioremediation activities. DNAPL that is suspected to be present in the HCIM Area will act as a continuing source of groundwater contamination and will likely preclude the attainment of cleanup levels for chlorinated VOCs for the foreseeable future. Some other COCs present in HCIM Area groundwater are not expected to naturally attenuate to any significant degree.

Institutional controls would be incorporated into the alternative to ensure that human health and the environment are adequately protected by Alternative HA-3. These controls would be the same as described for Alternative HA-1 in Section C.1.

C.4 ALTERNATIVE HA-4 –CONTAINMENT, DEWATERING, SVE, AND ISCO

Remedial Alternative HA-4 is similar to Alternative HA-3 except it replaces ISB with in situ chemical oxidation (ISCO) to reduce the mass of DNAPL and dissolved DNAPL constituents. Alternative HA-4 would include the following elements:

- The existing barrier wall isolating and enclosing near-facility impacted soil and groundwater;
- An upgraded groundwater recovery and pretreatment system, with greater capacity than the existing system;
- Surface cap/cover;
- Partial dewatering followed by SVE;
- ISCO in HCIM Area groundwater;
- The existing groundwater monitoring wells and a revised monitoring program; and
- Institutional controls.

The components of Alternative HA-4 would be implemented in phases. The first phase of remediation activities would include construction of new caps over currently uncapped areas. Partial site dewatering and SVE would be implemented as described for Alternative HA-3. ISCO would be implemented following decommissioning of the SVE/dewatering system and the return of HCIM Area groundwater elevations to pre-SVE levels.

ISCO involves the application of a chemical oxidant, such as potassium permanganate, sodium persulfate, or hydrogen peroxide, to react with organic contaminants. The specific oxidant that would be used for each groundwater interval within the HCIM Area would be selected during final design; for the conceptual design, it was assumed that potassium permanganate ($KMnO_4$) would be used as the oxidant. As discussed for Alternatives HA-2 and HA-3, the treatment would not likely be effective in the intermediate interval and would focus only on the shallow zone (above approximately 50 feet depth), which includes the shallow and water table depth intervals.

It is anticipated that groundwater recirculation would be necessary to effectively distribute the oxidant in the targeted treatment zones (the suspected DNAPL areas). A recirculation well system and monitoring well network would be utilized for Alternative HA-4 that is similar to the conceptual design for the ISB system of Alternative HA-2 (10 extraction wells and 22 injection wells) as described in Section 5.1.2. ISCO treatment of each targeted zone would be accomplished by withdrawing water from a central extraction well, mixing an oxidant with the extracted groundwater, and re-injecting it through four surrounding injection wells spaced 50 feet apart. Oxidant injection and groundwater recirculation would continue until un-reacted oxidant is detected in the extracted groundwater. Injection wells and extraction wells would be constructed with 40 feet of screen. The shallow injection/extraction wells would be installed to a depth of approximately 50 feet bgs to treat the water table and shallow groundwater intervals.

Repeat injections would be conducted periodically to maintain an oxidant concentration in the treatment zones capable of oxidizing chlorinated VOCs and their breakdown products. For the conceptual design in the FS, it was assumed that two injections would be performed each year over a 4-year period, for a total of eight injection events. The oxidant and required mass of oxidant to be injected would be determined from pilot testing. Based on the reducing conditions and elevated iron concentrations observed in HCIM Area groundwater, the soil oxidant demand of the treatment area was assumed to be 6 lb of $KMnO_4$ per cubic yard of treated aquifer (Haselow, 2003). It was assumed that 2,625 lb of $KMnO_4$ would be injected as a 2 percent solution in each recirculation cell during each injection event. A total of 26,250 lb of $KMnO_4$ would be injected during each event, and 210,000 lb of $KMnO_4$ total would be injected over all eight injection events. It is anticipated that each recirculation cell (consisting of one extraction well and four injection wells) would be operated for 24-48 hours during each injection event.

Pilot testing of Alternative HA-4 would be needed to select the most effective oxidant for the HCIM Area, confirm the effectiveness of this technology, confirm the injection mass, and determine the radius of influence of the extraction/injection wells. The pilot testing would be performed by installing one nested recirculation cell (i.e., one set of nested extraction wells and four sets of injection wells) and monitoring wells, conducting bench-scale treatability studies, completing an injection event, and conducting performance monitoring. Pilot testing could be completed within 6 to 9 months.

High levels of other oxidizable substances in the treated zone, such as soil organic material and reduced-state metals (e.g., ferrous iron), can significantly reduce the treatment efficiency and effectiveness of ISCO by consuming the oxidant. Typically, the majority of oxidant injected during ISCO treatment of impacted groundwater is consumed overcoming this soil oxidant demand. During the installation of the extraction and injection wells for the pilot study, soil samples would be collected from each targeted treatment zone for use in bench-scale treatability studies to evaluate the soil oxidant demand in the HCIM Area. These treatability studies would also be used to select the most effective oxidant for the HCIM Area. Following the completion of the bench-scale tests, a pilot test would be conducted by completing an injection event using the nested recirculation cell and conducting performance monitoring.

A monitoring well network is an integral part of Alternative HA-4. Four additional monitoring wells (two nested sets) would be installed to evaluate the effectiveness and performance of the ISCO system. Nested sets of monitoring wells would be installed at two locations to monitor the oxidant distribution in the water table and shallow groundwater intervals. Degradation of the groundwater COCs and consumption of the oxidant would be monitored within the injection, extraction, and monitoring wells. Upon dissolution, permanganate causes the solution to turn purple, which provides an indicator for the presence of unconsumed permanganate oxidant. The concentration of un-reacted oxidant in the injection, extraction, and monitoring wells would be evaluated with a colorimeter (such as a Hach Manganese LR, Pocket Colorimeter, or similar). It was assumed that quarterly monitoring of the wells would be conducting during the 4-year injection program, followed by 2 years of semiannual sampling, and annual sampling thereafter. Alternative HA-4 also includes the groundwater monitoring program included for the other alternatives.

Institutional controls would be incorporated into the alternative to ensure that human health and the environment are adequately protected by Alternative HA-4. These controls would be the same as described in Section C.1 for Alternative HA-1.

Although ISCO would reduce the mass of DNAPL suspected to be present within the shallow zone of the HCIM Area, it is unlikely to remove all DNAPL ganglia that may be present. Subsurface heterogeneities, preferential flow paths, and poor mixing in the subsurface may result in inefficient treatment. The mass of contaminants in the subsurface is unknown. It is therefore difficult to estimate the time that would be required for COC concentrations within HCIM Area groundwater to reach cleanup levels. It was assumed that ISCO would be implemented after completing dewatering/SVE, and that oxidant injections would occur over a 4-year period. Monitoring inside the barrier wall was assumed to continue for 2 years after the final oxidant injection to confirm treatment effectiveness. Implementation time for this alternative would be similar to HA-3, on the order of 5 to 9 years.

DNAPL that is suspected to be present in the HCIM Area will act as a continuing source of groundwater contamination and will likely preclude the attainment of cleanup levels for chlorinated VOCs for the foreseeable future. Some other COCs present in HCIM Area groundwater are not expected to naturally attenuate to any significant degree.

C.5 ALTERNATIVE HA-5 – CONTAINMENT, DEWATERING, SVE, STEAM STRIPPING, AND ENHANCED ANAEROBIC BIOREMEDIATION

Alternative HA-5 includes all of the elements of Alternative HA-3. In addition, steam injection would be conducted in an effort to reduce the mass of DNAPL suspected to be present in two areas within the HCIM Area in both the intermediate and shallow intervals. Enhanced anaerobic bioremediation would be implemented following steam injection to address remaining concentrations of chlorinated COCs; due to temperature limitations, enhanced bioremediation could not be implemented until subsurface temperatures cool (in the FS it was assumed temperatures would need to decrease to about 80ºF). Partial site dewatering and SVE would be conducted to treat elevated concentrations of VOCs in the vadose zone and address shallow residual DNAPL. This alternative, unlike the preceding alternatives, would target the total depth of chemical impacts within the HCIM Area with an aggressive technology, steam stripping, with the intention of trying to reduce restoration timeframes for meeting cleanup levels in the HCIM Area.

Alternative HA-5 would include the following elements:

- The existing barrier wall isolating and enclosing near-facility impacted soil and groundwater;
- An upgraded groundwater recovery and pretreatment system, with greater capacity than the existing system;
- Surface cap/cover;
- Partial dewatering followed by SVE;
- Steam injection in affected HCIM Area groundwater;
- Electron donor injection into remaining areas of affected HCIM Area groundwater;
- The existing groundwater monitoring wells and a revised monitoring program; and
- Institutional controls.

The components of Alternative HA-5 would be implemented in a phased approach. Phase 1 of remediation activities would include construction of new caps over currently uncapped areas. Partial de-watering would then be conducted flowed by SVE. Phase 2 of Alternative HA-5, which includes steam injection, would be implemented following the decommissioning of the SVE/dewatering system and the return of HCIM Area groundwater elevations to pre-SVE levels. In the FS it was assumed that groundwater recovery would require 1 year.

Steam injection would be conducted to mobilize the suspected DNAPL and aid in its removal from two locations within the HCIM Area. Steam injection mobilizes and removes DNAPL from the subsurface through several mechanisms (Davis, 1998). As steam is initially injected into the affected aquifer, it cools and condenses as it moves out into the formation. As more steam is injected, this cold water front is pushed through the formation toward an extraction well, flushing mobile contaminants from the pore spaces. As the formation heats up, hot water moves through the treatment zone, which reduces the viscosity of the contaminants and increases the capture of contaminants by the extraction well. When the formation has been heated sufficiently to allow steam to reach the contamination, additional contaminant mass is removed through volatilization and SVE. Unlike the above alternatives, steam injection is a technology that mobilizes COCs and, as such, cannot be implemented in the shallow zone alone. Targeting the shallow zone alone would risk mobilizing the DNAPL from that zone downward, as opposed to the DNAPL being captured and removed. For this reason, steam injection is being considered for both the shallow and intermediate zones. According to the available literature, steam stripping was successful in reducing VOC concentrations by as much as 98% in one study of shallow groundwater treatment in granular soils. Other studies indicate a much lower level of success in deeper and/or more variable soil types.

The conceptual design of the steam injection system includes installation of 18 steam injection wells, 18 dual-phase extraction wells, and two additional SVE wells for a total of eight SVE wells under Alternative HA-5. Four of the SVE wells installed during Phase 1 of Alternative HA-5 would also be utilized. Each treatment zone would consist of one centrally located extraction well, and four injection wells spaced 45 feet apart. Steam would be injected through the four extraction wells, and a centrally located dual-phase extraction well would recover mobilized DNAPL constituents, impacted groundwater, condensed steam, and vapor. SVE wells would operate over the treatment area to capture any vapors that escape the treatment zone. Two nested wells would be located at each steam injection well and dual-phase extraction well location. Each well would be constructed with 40 feet of screen. The shallow injection/dual-phase extraction wells would be installed to a depth of approximately 50 feet bgs to treat the water table and shallow groundwater intervals. The second well at each nested steam injection or dual-phase extraction well location would be installed to a depth of approximately 90 feet bgs to treat the intermediate groundwater interval. Dedicated, submersible, groundwater extraction pumps would be installed in each dual-phase extraction well approximately 5 feet above the bottom of the well. A pumping rate of 5 gpm would be maintained in each well. Based on the steam requirements for similar applications, it is estimated that approximately 720 tons/year of carbon dioxide (a greenhouse gas) would be produced during steam injection. Assuming a 5-year injection time, a total of about 3,600 tons of greenhouse gases would be released under this alternative.

The two additional SVE wells would be installed to a depth of 8 to 10 feet bgs and would be constructed with 5 feet of screen, for a total of eight SVE wells. The variable-speed, regenerative blower with a capacity of 1,000 cfm would be utilized to induce a vacuum of approximately 25 inches of water on each SVE and dual-phase extraction well. An Ecology underground injection permit may be required for steam injection, and an air permit would be required for the SVE system. It was assumed that the dewatering and SVE phase would require 4 years to complete.

The extracted groundwater, steam, and contaminated vapors would be treated in a treatment system consisting of a heat exchanger/condenser, vapor–liquid separator, catalytic oxidizer, and air stripper. The water vapor in the extracted vapor stream would be condensed and treated with the extracted groundwater by an air stripper prior to discharge to a POTW under a permit issued by King County. Chemical dosing and precipitation may also be necessary to remove elevated concentrations of metals that may be present in the extracted groundwater. A catalytic oxidizer would be used to treat VOCs in the extracted vapor stream prior to discharge to the atmosphere.

Steam injection could not be implemented in proximity to the HCIM barrier wall due to the potential for adverse impacts to the wall material. Therefore, a 50-foot buffer zone would be maintained between the areas to be treated by steam injection and the barrier wall. In addition, monitoring wells with temperature sensors would be installed to monitor temperature gradients throughout the treatment area and near the barrier wall. Two additional nested wells, one at each treatment depth, would be installed at each of three locations for a total of 10 monitoring wells (five nested pairs).

For the conceptual design in the FS, it was assumed that the steam injection system would be installed and would operate for a period of 5 years. Based on initial system performance testing, steam injection may be conducted in cycles. Under this operational scenario, SVE and dual-phase extraction would continue between steam injection cycles to depressurize the steam zone and create a thermodynamically unstable system. Cycling of steam injection in this manner has been shown to reduce the amount of steam required, and may potentially reduce the time to reach cleanup levels (Davis, 1998). The actual operational period of the system would likely be determined based on VOC concentrations in the extracted vapor and groundwater streams and whether the system had reached a point of diminishing returns. Groundwater monitoring within the HCIM Area would be conducted during the 5-year steam injection period.

Subsurface heterogeneities and preferential flow paths are expected to cause uneven heating in the treatment zone, resulting in inefficient treatment. In addition, significant portions of the suspected DNAPL areas may not be treatable by steam injection due to the proximity of the barrier wall and the presence of the TASCO building. Therefore, enhanced anaerobic bioremediation would be conducted following completion of steam injection (including cool-down) to further reduce the potential mass of DNAPL and dissolved-phase constituents in the HCIM Area. Enhanced anaerobic bioremediation would be implemented as outlined for Alternative HA-2.

For scheduling purposes it was assumed that the subsurface would cool to pretreatment temperatures within 2 years; however, preliminary calculations indicate that it could take as long as 20 years to cool sufficiently to support growth of organisms known to be capable of supporting reductive dechlorination of chlorinated VOCs. It was assumed that enhanced bioremediation injections would be conducted for 4 years with an additional 2 years (6 years total) of monitoring within the HCIM Area for enhanced bioremediation. Long-term monitoring at the CPOC has been included in the Outside Area alternatives.

Similar to the other alternatives it is likely that cleanup levels would not be met within a reasonable timeframe by this technology due to the heterogeneities within the aquifers. Some recontamination of the Intermediate and Shallow Aquifers due to diffusion from the silt lenses and the aquitard is expected. In addition, some COCs present in HCIM Area groundwater are not expected to naturally attenuate to any significant degree.

The implementation period for this alternative could be much longer than for the other alternatives. Designing and implementing the steam injection technology would likely take 1 to 2 years, plus at least another 1 year for pilot testing. Actual implementation time is anticipated to take about 5 years, as about 1 year would be needed to heat the subsurface to the necessary temperature. Following treatment by steam injection, the site would need several years for ground temperatures to cool prior to implementing enhanced biodegradation, with a 4-year period projected for substrate injection. As a result, total implementation time for this alternative would be about 16 years at minimum and could extend to more than 25 years if the subsurface cools slowly. It would not be possible to return the site to productive use during the remediation period. Institutional controls would be incorporated into the alternative to ensure that human health and the environment are adequately protected by Alternative HA-5. These controls would be the same as described for Alternative HA-1.

C.6 ALTERNATIVE HA-6 – DEWATERING, SVE, STEAM STRIPPING, PUMP-AND-TREAT, AND EXCAVATION

This alternative combines steam injection and SVE/dewatering with groundwater extraction for mass reduction. In addition, vadose zone soil containing COC concentrations above cleanup levels for PCBs and metals would be excavated for off-site disposal. Alternative HA-6 would include the following elements:

- The existing barrier wall isolating and enclosing near-facility impacted soil and groundwater;
- An upgraded groundwater recovery and pretreatment system with greater capacity than the existing system;
- Surface cap/cover;
- Partial site dewatering followed by SVE;
- Steam injection in affected HCIM Area groundwater;
- Groundwater recovery for mass reduction;
- Excavation and off-site disposal of highly impacted soil;
- Reconstruction of the cap following excavation;
- The existing groundwater monitoring wells and a revised monitoring program; and
- Institutional controls.

Alternative HA-6 would be implemented in phases. Phase 1 would include capping of uncapped areas, dewatering, and implementation of SVE, as described for Alternative HA-3. Following decommissioning of the SVE system, steam injection would be conducted in Phase 2 to reduce the mass of DNAPL suspected to be present within the HCIM Area, as detailed for Alternative 5. Phase 2 of Alternative HA-6 would include continued groundwater recovery in the two suspected DNAPL areas following cessation of steam injection to further reduce the mass of chlorinated VOCs and other COCs present in HCIM Area groundwater. In addition to VOC recovery, the recovery system may reduce metals concentrations present within the suspected DNAPL areas. As discussed in Technical Memorandum No. 1 (Geomatrix, 2006a), arsenic has been detected in water table and intermediate monitoring Wells 1-S-1 and 1-I (located within the suspected DNAPL area in the former North Field) at concentrations greater than 20 and 50 times the cleanup level, respectively. In addition, copper, nickel, and barium (Well 1-S-1 only) have been detected in these wells above their respective cleanup levels.

The groundwater extraction wells for the steam injection system would be utilized for groundwater recovery, and each extraction well would be pumped at a rate of 2 gpm. The extracted groundwater would be treated by the steam injection groundwater treatment system and then re-injected into the shallow and intermediate groundwater depth intervals to flush additional contaminants toward the extraction wells and prevent dewatering of the HCIM Area. Based on the steam requirements for similar applications, it is estimated that approximately 720 tons/year of carbon dioxide (a greenhouse gas) would be produced during steam injection. Assuming a 5-year injection time, a total of about 3,600 tons of greenhouse gases would be released under this alternative.

Concentrations of chlorinated VOCs and metals in the water table, shallow, and intermediate groundwater intervals would be monitored during groundwater extraction in existing HCIM Area monitoring wells and in wells installed to monitor steam injection temperature gradients. The operational period of the groundwater extraction system would depend on several factors, including:

- The mass of DNAPL currently present within the HCIM Area;
- The effectiveness of the steam injection program;
- The mobility and concentrations of the contaminants remaining after cessation of steam injection; and
- The capture efficiency of the groundwater extraction wells.

The groundwater extraction/re-injection system was assumed to operate for a total 15 years; it was assumed that pumping would be maintained during SVE and steam injection operations.

Semiannual groundwater samples would be collected for VOC and metals analysis inside the barrier wall during this period to monitor the effectiveness of the remediation systems. It was assumed that monitoring inside the barrier wall would cease when groundwater recovery is stopped. Long-term monitoring at the CPOC is included in the Outside Area alternatives.

The third phase of Alternative HA-6 would include excavation and off-site disposal of soil containing elevated concentrations of inorganic COCs and PCBs within the HCIM Area. It is projected that the excavation would be done after completing steam injection, probably about 10 years after commencing implementation of this alternative. Soil currently containing VOCs and SVOCs would not be excavated, because these areas would be addressed by SVE, as discussed above. Based on soil sampling results presented in the RI Report, excavation and off-site disposal would be implemented in two areas. The excavation areas would include PCB- and metals-impacted soil near the northeastern UPPR property boundary and a small area with elevated concentrations of metals around former sampling location HAC-17. The structural integrity of the HCIM barrier wall and the TASCO building would be protected during excavation activities by maintaining a minimum 5-foot buffer around the barrier wall and building foundation. In addition, excavation sidewall slopes of 1.5:1 (horizontal to vertical) would be maintained away from the barrier wall and building foundation.

Excavations would be completed to the top of the groundwater (approximately 8 to 10 feet bgs). It is anticipated that approximately 2,000 bank cubic yards of soil would be removed for off-site disposal. The excavated soil would likely be classified as dangerous waste and would have to be transported by licensed haulers to appropriately permitted disposal facilities.

Confirmation soil samples would be collected from the sidewalls of the excavations at a frequency of one per 50 linear feet of excavation sidewall. A minimum of one confirmation sample would be collected from each excavation sidewall. Confirmation samples would not be collected from the base of the excavations, because the excavations would be completed to the water table. Following completion of soil removal, the excavations would be backfilled with clean fill and compacted. The disturbed areas would be repaved with a minimum of 3 inches of asphalt to replace the existing cap over the excavation areas.

Implementation of this alternative would be somewhat faster than HA-5, but longer than HA-4, with a project implementation time of about 17 years. This assumes that the final groundwater pump and treat portion of the alternative could be conducted during the time that temperature remains elevated in the subsurface. It is anticipated that redevelopment could be implemented within about 18 years after commencing implementation of the alternative.

Institutional controls would be incorporated into the alternative to ensure that human health and the environment would be adequately protected by Alternative HA-6. These controls would be the same as described above for Alternative HA-1.

APPENDIX D

Preferred HCIM Area Cleanup Action

APPENDIX D

PREFERRED HCIM AREA CLEANUP ACTION

Sections D.1 and D.2 below describe the CAP's preferred HCIM Area cleanup option and Ecology's rationale for selecting it. The preferred alternative is not the alternative chosen by PSC in FS Technical Memorandum #5; nor is it exactly the same as any one of the six alternatives evaluated in that memorandum or discussed in Appendix C.

D.1 IDENTIFICATION AND RATIONALE FOR THE HCIM AREA ACTION

The area addressed by the CAP includes the properties currently owned by PSC (the facility and the adjacent TASCO property), properties adjacent to the PSC properties that were affected by releases from the facility (Union Pacific Rail Road [UPRR] Argo Yard, Aronson, and SAD properties), and the contiguous areas affected by releases from the facility extending downgradient (west) to Fourth Avenue South. The **HCIM Area** is a part of this larger east-of-4th area, and includes the contaminated soils and groundwater behind the subsurface barrier wall.

The comparative evaluation of HCIM Area alternatives is described in PSC's FS documents and summarized in Section 5 of the CAP text. Based on the evaluation performed in their FS, PSC identified Alternative HA-1 as their preferred alternative. The preferred alternative was later modified by Ecology to incorporate additional remedial components, primarily those associated with alternative HA-3. Principal elements of the preferred cleanup action for the HCIM Area selected by Ecology are described below.

- The existing barrier wall will be maintained to isolate and enclose near-facility impacted soil and groundwater (the barrier wall is described in detail in the HCIM Implementation Report, Geomatrix, 2004). This was a component of all six HCIM Area alternatives.

- The existing groundwater recovery and pretreatment system described in the HCIM Implementation Report (Geomatrix, 2004) will maintain an inward gradient in groundwater flow toward the HCIM Area. This was a component of all six HCIM Area alternatives.

- The existing groundwater recovery system will be operated for a 1- to 2-year period at the maximum operational capacity consistent with the treatment system and the King County Discharge Permit. The goal of this action is to lower the groundwater table (partial dewatering) and increase the depth of the vadose zone to allow more efficient SVE. This is a component similar to that included for alternatives HA-3 through HA-6.

- An SVE system will be installed and operated within the HCIM Area for a maximum of 18 months to remove VOCs from the expanded (i.e., partially dewatered) vadose zone. This is a component similar to that included for alternatives HA-3 through HA-6.
- Approximately 200 cubic yards of soil on the former TASCO property that contained concentrations of polychlorinated biphenyls (PCBs) above 10 mg/kg will be excavated and disposed off site.
- Any unpaved portions of the HCIM Area will be paved to promote stormwater runoff, minimize the potential for erosion of affected soil, and prevent direct exposure to soil COCs. This was a component of all six HCIM Area alternatives.
- Following SVE operations, an ISB system (as described for Alternatives HA-2 and -3) will be installed and operated for 4 years.
- The existing HCIM performance monitoring will continue (as proposed by all six HCIM Area alternatives).
- The institutional controls described for Alternatives HA-1 through HA-6 will be implemented to ensure protection of public health and the environment.
- Financial assurance will be provided by PSC per WAC 173-340-440(11) for a period of 100 years to ensure continued long-term O&M (including wall repair) of the cleanup action.

The HCIM Area cleanup action provides active hydraulic containment behind/within the low-permeability subsurface barrier wall and operation of a groundwater extraction and treatment system, which results in an inward groundwater gradient. In addition, the final cleanup action incorporates active remediation to reduce COC mass within the Area. The existing groundwater extraction system will be operated at maximum capacity to lower the water table by as much as 3 feet, thereby allowing SVE to remove much of the VOC mass from shallow soils. SVE will be followed by an extensive ISB action. ISB will be operated for four years, which will significantly enhance the anaerobic degradation of chlorinated solvents, among the most mobile and toxic of the COCs in the shallow zone.

The groundwater recirculation system included as part of the ISB program will promote bioremediation to the extent practicable within the most highly contaminated shallow zone areas within the barrier wall. ISB using active recirculation well networks has been proven effective at reducing contaminant mass in high concentration areas such as DNAPL ganglia zones within permeable, homogeneous soils. The shallow zone, particularly the upper portion of the shallow zone, is highly permeable and relatively homogeneous. The deeper portion of the shallow zone consists of more interbedded sand and silt, conditions in which ISB is significantly less effective. The intermediate sand and silt unit would not be addressed by this remedy, since the lower permeability and greater heterogeneity of that unit make the technology ineffective.

Following completion of ISB, the groundwater within the HCIM Area will remain isolated from the environment by the barrier wall and groundwater recovery system. It is expected that groundwater conditions will remain reducing within the HCIM area for decades, support long-term biodegradation of the remaining chlorinated solvents.

The HCIM Area remediation approach can be readily implemented. Phasing the implementation will take on the order of four to six years. Dewatering and SVE will be initiated first followed by ISB, although some overlap in the implementation schedule may be feasible. The containment and monitoring components are currently in place as a result of the HCIM. Long-term O&M would include routine inspection and maintenance of the barrier wall and existing surface cover, as well as maintenance of the groundwater recovery and treatment system.

The primary potential for failure of the physical components of the proposed cleanup action would be catastrophic seismic events in the area or construction-related disturbance of the surface cover or barrier wall. Failure of the surface cover or barrier wall by either of these scenarios would be corrected by repairing the damaged areas using proven technologies, currently available.

The cleanup action for the HCIM Area would fully attain remediation objectives. It would also:

- prevent direct contact with soils and inhalation of dust within the HCIM Area by maintaining a paved cover over affected soils, and by implementing institutional controls that would require appropriate health and safety precautions for future subsurface construction;
- reduce risks due to inhalation of vapors by incorporating institutional controls requiring vapor intrusion provisions for any future buildings that may be occupied. In addition, SVE will reduce concentrations of VOCs in the vadose zone which, when combined with reductions in mass from the ISB, should reduce risks associated with contaminated vapors;

- protect human and ecological receptors in the Duwamish Waterway by effectively containing affected groundwater east of Denver Ave., and limiting the further release of COCs to the Outside Area;

- use an approach for which key components have already been substantially implemented. The complete remedy could be fully constructed and implemented within four to six years following finalization of the CAP (with only minimal delays for engineering, permitting, and construction);

- provide long-term physical containment of near-facility impacted soil and groundwater through engineered barriers constructed of durable, natural materials;

- establish an isolated environment in the contained area to promote and maintain active anaerobic biological degradation of chlorinated solvents in groundwater;

- require an HCIM performance monitoring plan integrated with the monitoring network for the Outside Area that would allow ongoing monitoring and assessment of the effectiveness of the HCIM Area remedial measures;

- consist of a reliable, low-maintenance remediation approach using proven, robust technologies;

- create minimal short-term risks and have minimal potential for causing public concern about exposure to site constituents during construction;

- be fully compatible with the preferred cleanup action for the Outside Area; and,

- comply with MTCA regulations (WAC 173-340), the Dangerous Waste Regulations (WAC 173-303), RCRA regulations, and the requirements of the Permit.

The paragraphs below describe how the HCIM Area cleanup action meets the criteria for selecting a cleanup action under MTCA (per WAC 173-340-360(2) and 173-340-380(1)(a)(viii)).

Overall Protection of Human Health and the Environment

The soil cleanup action, including SVE, surface cover, and institutional controls, will be protective of human health and the environment by reducing concentrations of COCs that may contribute to groundwater contamination and preventing direct contact with soils and inhalation of dust.

The groundwater cleanup actions for the HCIM Area provide protection of human health and the environment primarily via containment and institutional controls. The barrier wall and surface cover for the HCIM Area will effectively contain primary source areas for soil and groundwater, thereby minimizing the potential for migration and for exposure via direct contact. Potential risks due to inhalation of contaminated indoor air caused by vapor intrusion will be mitigated by continued implementation of the VIAM program and institutional controls on the use of the PSC property.

Compliance with Cleanup Standards

Compliance with cleanup standards may be achieved through use of containment. The cleanup action's reliance on containment and institutional controls to protect receptors, while leaving some contamination at concentrations exceeding cleanup levels, can therefore be considered to comply with MTCA cleanup standard regulations (see WAC 173-340-740 (6)(f) for soils and 173-340-720(8)(c) for groundwater). Groundwater contamination that is "behind" the point of compliance need not be remediated to cleanup levels within a reasonable timeframe.

Compliance with Applicable State and Federal Laws

The final cleanup action will be designed and implemented so that it is fully compliant with these ARARs.

Compliance Monitoring

The final cleanup action will include Compliance Monitoring.

Permanent Solutions

None of the FS alternatives are capable of reducing all COCs in groundwater and soils to cleanup levels. Even HA-5 and HA-6 are unlikely to be so effective as to attain groundwater cleanup levels for all COCs, and do not propose to achieve all soil cleanup levels. This is because (1) none of the FS alternatives were designed to permanently destroy or otherwise treat all COCs in HCIM Area soils, and (2) there does not appear to be a DNAPL remedy available that can confidently attain low groundwater cleanup levels. Ecology did not ask PSC to include an alternative that would permanently destroy or otherwise treat all COCs in HCIM Area soils. This would essentially entail demolishing the cap on PSC's property and excavating all soils throughout the RCRA facility from ground surface to the water table. Although we did ask PSC to include a groundwater action capable of remediating the DNAPL, PSC was unable to identify a technology that could achieve cleanup levels with confidence.

The selected cleanup action relies primarily on containment, but includes permanent solutions to the extent practicable. It permanently destroys key facility COCs: VOCs in soil will be collected and treated by SVE; chlorinated VOCs in groundwater from ground surface to a depth of 50 feet will be biodegraded to innocuous byproducts. Though these actions may not attain cleanup levels for all the targeted substances, they will significantly reduce their mass. In the event of a major wall failure, then, the groundwater contamination released into the downgradient area would be less concentrated and pose less of a threat.

Reasonable Restoration Timeframe

Some cleanup levels in the HCIM Area will not be attained within a reasonable timeframe. Some may never be attained. The proposed action does not aim to achieve cleanup levels for all substances currently present at elevated concentrations. Instead, its objective is to reduce the mass of certain COCs (VOCs, primarily) and rely upon containment and institutional controls to protect human health and the environment. Containment and institutional controls will need to be relied upon for decades, and probably centuries. Actions which are capable of more quickly reducing shallow groundwater VOC concentrations and/or mass behind the wall, however, offer the potential for minimizing the need for a major future re-implementation of the vapor intrusion assessment and mitigation program in the Outside Area. Ecology's selected action has been developed with this benefit in mind.

Consideration of Public Concerns

The proposed action was developed by assuming the public favors a cost-effective remedy for the PSC site that will be adequately protective while being implemented, and will result in an environment that does not pose unacceptable health risks. Ecology has also assumed that the public supports the barrier wall interim action that was constructed five years ago. The proposed HCIM Area action was further based on the assumption that public concerns regarding contaminated soils and groundwater behind the barrier wall are primarily:

a) the possibility that groundwater could escape and discharge to the Duwamish Waterway (and the possibility of contaminating the river);

b) the possibility that shallow groundwater could escape and move downgradient. It could then volatilize and contaminate indoor air;

c) that soils could be blown by wind to off-property locations;

d) that people on the property in the future could come into contact with the soils, or that precipitation could carry soil contamination down to the water table; and,

e) that responsibility for maintaining the wall and cap might be evaded.

Ecology's selected action was developed to address these concerns.

D.2 ELEMENTS NOT INCLUDED IN ECOLOGY'S HCIM AREA ACTION

In Ecology's July 3, 2007 letter to PSC, responding to FS Tech Memo #5, the Department identified remedial elements we believed should be included in the HCIM Area preferred alternative. Subsequently, after meeting with PSC in later 2007 and discussing various possibilities for the preferred alternative, we decided that several of these elements need not be included in the cleanup action proposed to the public in the draft CAP. The following paragraphs summarize these elements and Ecology's rationale for deciding they could be omitted from the proposed cleanup action.

PCB-contaminated soils

Ecology had asked PSC to include the HA-6 soil excavation element in the HCIM Area preferred alternative. Instead, PSC will investigate PCB levels in soils on the old White Satin Sugar (TASCO) property in an area where past sampling suggested elevated COC concentrations. If PCB levels in this area are elevated above applicable Cleanup Standards, and appear to be higher than concentrations known to exist in other parts of the site not covered by thick microsilica concrete capping, PSC will implement hot spot soil excavation and appropriate off-site disposal.

Our rationale for proposing a different action than the action included in HA-6 is:

a) PSC and Ecology agree that PCB contamination in site soils covered by the thick, microsilica concrete cap can, and should, be left in place. As such, vadose zone areas eligible for excavation are limited to those covered by asphalt or other less dense, permeable coverings (e.g., covered only by asphalt). An area on the old White Satin Sugar property, depicted in Figure 4-9 of Tech Memo #5 and included as part of the excavation action proposed for alternative HA-6, is such an area.

b) In October 2007, PSC discovered that inorganic COC data for the old White Satin Sugar property area were mis-reported. Certain metals COC concentrations were, in fact, a thousand-fold lower than reported in Tech Memo #5. Metals contamination, therefore, will not require excavation and removal.

c) A limited investigation conducted in the area has better defined PCB concentrations and identified soils to be removed.

Financial assurance for a future DNAPL-treatment technology

Ecology had also asked PSC to include financial assurance in the preferred alternative to fund a future technology that would be capable of effectively treating the DNAPL throughout the HCIM Area saturated zone. Our intention was for the company to set aside money that could be used once a practicable technology became available that could deal permanently with the non-aqueous contamination that is suspected to be present at various depths. Instead, PSC will provide financial assurance for wall maintenance and repair for a 100-year timeframe.

It is uncertain whether such a DNAPL technology will be developed in the future, how much it will cost, and whether – in the future – this cost will be viewed as justifiable (worth the benefits). So, first, there is the problem of estimating such a technology's cost today. Second, regardless of how the cost-estimating is performed, the total cost will have to be assumed to be substantial. Current technologies, which are unlikely to fully remediate the DNAPL, would cost tens of millions of dollars (in today's dollars). We should expect a future technology to also be expensive. Asking PSC to set aside such a large amount of money – in addition to setting aside money to maintain and repair the wall – results in a substantial financial burden for the company. Justifying the expense would be difficult enough were the technology known, and proven to be effective today; justifying it based on the hope that such a technology might be developed some day is even more difficult, and PSC has refused to make such an investment.

It is Ecology's intention, then, to require that the barrier wall be maintained and repaired for as long as it is needed to contain contaminated groundwater. If, in the future, a technology becomes available that will so effectively clean-up groundwater behind the wall that continued maintenance and repair of the wall becomes unnecessary, the party responsible for the HCIM system at that time, and Ecology, will determine if the costs of implementing this technology are justified by the resulting permanence of the remedy and the financial benefit of curtailing future maintenance and repair of the barrier wall.

APPENDIX E

Remedial Alternatives Evaluated in the FS for the Outside Area

APPENDIX E

REMEDIAL ALTERNATIVES EVALUATED IN THE FS FOR THE OUTSIDE AREA

The area addressed by the CAP includes the properties currently owned by PSC (the facility and the adjacent TASCO property), properties adjacent to the PSC properties that were affected by releases from the facility (Union Pacific Rail Road [UPRR] Argo Yard, Aronson, and SAD properties), and the contiguous areas affected by releases from the facility extending downgradient (west) to Fourth Avenue South. The **Outside Area** is a part of this larger east-of-4th area, and includes the contaminated soils and groundwater beyond ("outside") of the subsurface barrier wall.

Sections E.1 through E.5 below describe the six Outside Area cleanup options evaluated in PSC's FS Technical Memorandum #5 and in the Revised Characterization and Preferred Cleanup Approach for the Argo Yard Property (Geomatrix, 2008a).

E.1 ALTERNATIVE OA-1 – MONITORED NATURAL ATTENUATION

Alternative OA-1 relies on monitored natural attenuation (MNA), the existing surface cover, the existing vapor intrusion assessment and mitigation (VIAM) program,[1] institutional controls, and long-term performance monitoring to address site COCs and potential exposure pathways in the Outside Area. Under this alternative, MNA would be used to reduce COC concentrations in impacted groundwater in all Outside Area groundwater remediation areas. Evidence has shown that natural attenuation is capable of degrading TCE and its daughter products within the Outside Area groundwater plume. Other organic COCs, including chloroethanes, petroleum hydrocarbons, aromatics, and PAHs, are known to degrade naturally under appropriate conditions. Metals can also be attenuated through transformation reactions.

Available groundwater monitoring data indicate that groundwater COCs originating at or near the RCRA facility are currently being attenuated to achieve groundwater cleanup levels prior to reaching the Duwamish Waterway (PSC, 2007a,b,c,d). Completion of the HCIM, which occurred in early 2004, has isolated the former source area from the Outside Area, thereby

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[1] This program has been called the "Inhalation Pathway Interim Measure" (IPIM). It was implemented during the RI/FS to protect indoor receptors threatened by vapor intrusion. In all five Outside Area alternatives this program is proposed to remain active until shallow groundwater cleanup levels are attained. The program, post-CAP, is no longer an "interim action" and is referred to as the *VIAM*.

substantially reducing the release of COCs to the Outside Area.[2] Since source area containment will limit future migration of COCs, it is expected that the concentrations of COCs within the Outside Area groundwater will continue to decline as the result of ongoing natural attenuation processes.

Recent data from quarterly groundwater monitoring events indicate that concentrations of VOCs in the monitoring wells immediately downgradient of the barrier wall have fallen significantly since the barrier wall was installed (Geomatrix, 2007c). Several wells have seen an order of magnitude drop in VOC concentrations. Trends of decreasing COC concentrations are strongest nearest the wall, but declining VOC trends can be seen as far downgradient as 4th Avenue South. Additionally, recent groundwater monitoring data (PSC, 2007a,b,c,d) indicate that the area immediately downgradient from the barrier wall is currently attaining the remediation levels defined in Technical Memorandum #1 (Geomatrix, 2006a).

The presence of cis-1,2-DCE and vinyl chloride in Outside Area groundwater indicates that active biodegradation of chlorinated solvents in the Outside Area is occurring. Similarly, groundwater monitoring data and fate and transport modeling (Geomatrix, 2006a) show that most non-chlorinated organic compounds are fully degraded upgradient of Denver Avenue South. Available monitoring data also indicate that 1,4-dioxane concentrations are attenuating (via dilution and dispersion) to cleanup levels prior to discharge to the Duwamish Waterway, although concentrations within the shallow and intermediate depth intervals of the Outside Area continue to exceed the cleanup level.

The results of chlorinated VOC fate and transport modeling are detailed in Appendix B of Technical Memorandum No. 1 (Geomatrix, 2006a). This groundwater modeling was performed using a range of biodegradation rates for the chlorinated VOCs. Using biodegradation rates calculated from a mass flux approach and calibrating the model to actual monitoring data, the modeling results indicate that cleanup levels will eventually be met for these contaminants without implementation of a cleanup action (beyond MNA).

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[2] As part of the FS groundwater fate and transport evaluation (Appendix B of Technical Memorandum No. 1, Geomatrix, 2006a), it was conservatively estimated that approximately 0.03 lb per day (lb/day) of total site COCs could flow through the barrier wall under non-pumping conditions (i.e., there would be no inward gradient). Modeling results show that this conservative estimate of flux through the wall would not adversely affect attainment of remediation objectives. MNA should ultimately attain cleanup levels at the CPOC and downgradient, even if pumping were to be discontinued within the HCIM Area.

As the COC mass within the Outside Area decreases, it is expected that the plume of affected groundwater within the Outside Area will contract, ultimately attaining groundwater cleanup levels at and downgradient of the CPOC. Based on the modeling performed during the FS, it was estimated that MNA would attain groundwater cleanup levels at the CPOC (immediately downgradient of the barrier wall) within approximately 26 years. This became the restoration timeframe, then, for alternative OA-1. As discussed in Technical Memorandum No. 1 (Geomatrix, 2006a), the water table interval has the highest concentrations of TCE and is expected to take the longest time to reach cleanup levels for all COCs. The modeling results predict that TCE will be attenuated to below cleanup levels in the Outside Area water table interval within approximately 26 years, while PCE and vinyl chloride at this depth are predicted to decrease to cleanup levels within 12 and 9 years, respectively. Available groundwater monitoring data support the MNA evaluations performed to date and the fate and transport modeling projections of eventual attainment of cleanup levels. However, further monitoring is required to confirm the modeling results and the effectiveness of natural attenuation within the Outside Area.

The modeling was also used to derive remediation levels (RLs) that would need to be attained at the CPOC to ensure that COC concentrations in groundwater discharging to the Duwamish Waterway would be less than surface water-based cleanup levels. These RLs were established, and are currently being met at the CPOC for the indicator COCs. Therefore, no Outside Area alternative appears to need an aggressive remedial component to protect the river by expeditiously attaining RLs.

Alternative OA-1 would rely on existing surface cover and implement institutional controls to address contaminated soils. Contaminated areas of soil on the SAD property and a 15-foot wide strip of PSC property that is located between the barrier wall and the SAD property line would remain covered by the current concrete and asphalt surface cover on the PSC property and pavement on the SAD property. This would prevent contact with impacted soils and prevent surface water infiltration. Risks associated with contaminated soils in the western portion of the UPRR Argo Yard property immediately adjacent to PSC's property, would be addressed by institutional controls.

PSC's existing vapor intrusion program (IPIM) would continue to address the inhalation exposure pathway in the Outside Area. Vapor intrusion mitigation systems currently in place under the program would be maintained as part of this remedial alternative to ensure that the inhalation pathway is adequately addressed until such time as applicable groundwater cleanup levels are met throughout the Area. After it has been confirmed that groundwater concentrations within the water table interval have attained vapor intrusion-based cleanup levels, the program (called the *VIAM* program after CAP finalization) could be discontinued.[3] It was assumed for all five OA alternatives that the VIAM program would be maintained for three years after attainment of cleanup levels at the CPOC. Then, two years of groundwater monitoring were assumed to be needed after discontinuing the VIAM program to confirm continued compliance with cleanup levels.

A monitoring well network is obviously an integral part of MNA. <u>All five</u> Outside Area alternatives include the same performance and CPOC monitoring program since performance monitoring is common to all remedial alternatives (Figure 15). The three general components of the monitoring program are described below.

- HCIM Performance Monitoring: this monitoring element includes monitoring of wells located both inside and outside the barrier wall to assess the effectiveness of the barrier wall in providing containment for the HCIM Area.
- CPOC Compliance Monitoring: this monitoring element addresses monitoring of Outside Area CPOC wells to assess attainment of the cleanup standard for each alternative at the CPOC.
- Outside Area Remediation Monitoring: this program element is specific to the Outside Area remediation alternatives, and includes performance monitoring of wells located downgradient of the CPOC (between the CPOC and Fourth Avenue South) as appropriate for each specific remedial alternative to monitor cleanup of the plume and compliance with cleanup levels.

When combined, these three elements would provide a comprehensive monitoring program (please see Figure 15).

The groundwater monitoring assumed for Alternative OA-1 would include CPOC wells located immediately downgradient of the HCIM barrier wall, and wells located downgradient from the CPOC to Fourth Avenue South. The monitoring wells include wells for the water table, shallow, and intermediate depth intervals, as well as the Deep Aquifer. The CPOC wells would

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[3] Individual mitigation systems may not need to be operated as long as the VIAM program. Groundwater cleanup levels have been derived to be protective of the vapor intrusion pathway assuming <u>residential</u> exposure to indoor air. They have also been set to MTCA B 1E-6 risk levels <u>per VOC</u>, which is more conservative than the current trigger level for installing mitigation systems (1E-5 total risk for all VI-related VOCs). Therefore, the “trigger” concentrations for requiring a mitigation system are greater than the groundwater cleanup levels for both commercial/industrial buildings and residences.

be monitored to verify that RLs continue to be met and that cleanup levels are attained within a reasonable timeframe. The Outside Area monitoring wells downgradient from the CPOC would be monitored to assess groundwater quality between the CPOC and Fourth Avenue South and to ensure that cleanup levels are attained within a reasonable timeframe. Following attainment of cleanup levels in the Outside Area, the CPOC and HCIM performance monitoring wells, and some additional Outside Area wells, would be monitored over the long term to confirm effective containment of the HCIM Area and continued compliance with cleanup standards.

Institutional controls are a key component of most remedies relying on relatively long cleanup periods to ensure that human health and the environment are adequately protected during the restoration time. For alternative OA-1, the following institutional/administrative controls would be established or otherwise relied upon:

- Limited withdrawal and use of groundwater within and downgradient from the east-of-4th site area. Currently, the City of Seattle has a bylaw preventing the withdrawal of groundwater for use as a drinking water source, and this will serve as the administrative control for groundwater use. PSC would either ensure that this bylaw remained in force, or – in the event it was modified or retired – propose to Ecology an alternative control, or set of controls, that would serve a similar purpose. Once the control was approved, PSC would implement it, or otherwise demonstrate to Ecology that is was in force.

- Where groundwater COC concentrations exceed cleanup levels for direct exposure (meaning: ingestion or dermal contact), PSC will periodically notify the community and utilities that appropriate personal protective equipment should be used and that exposure monitoring should be performed to protect workers who may contact the water or inhale vapors associated with the water. This notification would not "control" behavior.[4] A "control" to make sure the recommended actions are taken cannot be readily implemented within the Outside Area. The notification will only inform those potentially at risk.

- PSC will maintain a vapor intrusion assessment and mitigation (VIAM) program, and maintain mitigation systems until monitoring data indicate shallow groundwater is below cleanup levels based on the inhalation pathways (as described in Technical Memorandum 3, Pioneer, 2006). Maintaining the vapor intrusion assessment and

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[4] During preliminary discussions, City staff indicated to PSC that they cannot enforce such requirements, but that they can put notices in permits and on their permitting documents to provide notification of the contamination issues.

mitigation program would be a requirement of PSC's RCRA facility permit and/or order.

In addition, the City would be notified that new buildings in the Outside Area, where shallow groundwater concentrations exceed the inhalation pathway cleanup levels, should be constructed with appropriate vapor barriers. This is not an enforceable control, but supplements the VIAM program discussed above.

- PSC will inspect and maintain the current surface cover on the portion of the Outside Area that contains COC concentrations in soils above cleanup levels. This would be required by PSC's permit and/or order. However, for properties not owned by PSC, access to perform the inspection and maintenance would need to be assured through a legal mechanism.

- PSC will ensure use of appropriate personal protective equipment and compliance with the HAZWOPER requirements specified in 29 CFR 1910.120 are for all subsurface work conducted within their property boundaries. Since contaminated soil areas not owned by PSC are owned by industrial entities, it is expected that appropriate institutional controls would be negotiated and established with the owners (UPRR and SAD).

- PSC will work with the Seattle Department of Public Health to develop appropriate health advisories or other documentation to disseminate information regarding potential risks associated with the affected groundwater plume. This is not an enforceable control, but supplements the bylaw discussed in the first bullet.

- PSC will conduct public meetings at appropriate time intervals to provide information to the general public regarding potential risks and appropriate measures to mitigate risks. This is not an enforceable control, but supplements the other controls and notifications discussed above.

Under alternative OA-1 COC concentrations present in Outside Area groundwater would gradually decrease. Natural biodegradation would permanently destroy both chlorinated and non-chlorinated VOCs and most SVOCs (though not 1,4-dioxane). Metals would be converted to less mobile and less toxic forms after natural (pre-release) groundwater geochemical conditions return to the area. The FS predicted that the affected groundwater within the Outside Area could fully attain cleanup levels under this alternative within about 26 years, assuming that conditions continue as they are at present. Based on available site characterization data, MNA could achieve groundwater remediation objectives and, coupled with the other components included in the alternative, address the primary exposure pathways for groundwater within the Outside Area.

However, it is also true that this alternative would not permanently reduce any soil contamination in the Outside Area through active measures. Existing cover and institutional controls would be relied upon to protect receptors, and only the former would protect underlying groundwater quality. Nor is it certain that all groundwater COCs would attain their cleanup levels within a reasonable timeframe at and downgradient of the CPOC via MNA. 1,4-dioxane, vinyl chloride, and some inorganic substances may not naturally attenuate as predicted. 1,4-dioxane will only attenuate via dilution and dispersion, and there is considerable uncertainty as to its ability to attain cleanup levels throughout the Outside Area within a timeframe that is similar to timeframes associated with alternatives that supplement natural attenuation with more aggressive mass reduction.

E.2 ALTERNATIVE OA-2 – SVE, ENHANCED BIOREMEDIATION, PCB EXCAVATION, AND SURFACE COVER

Alternative OA-2 incorporates active remedial action for both soil and groundwater within the Outside Area. Soils in the southwestern portion of Argo Yard that are contaminated with PCBs would be excavated for off-site disposal. Vadose zone soils in the western part of PSC's former west field that are contaminated with VOCs would be remediated using SVE. Enhanced anaerobic bioremediation would then be implemented to reduce chlorinated VOCs in groundwater in this area. Surface cover would be placed over a small area in the southern portion of the 734 S. Lucile St. property.

COCs are present on a parcel of Argo Yard leased by PSC from UPPR where empty drums were stored historically. This area is impacted with a combination of VOCs, PCBs, SVOCs, and metals at concentrations above cleanup levels. Under Alternative OA-2, excavation and off-site disposal of soils would be implemented within this part of Argo Yard to remove PCB-contaminated soil down to MTCA Method A industrial cleanup levels.[5] The excavation would be completed to a depth of approximately 5 to 8 feet bgs. In the FS it was anticipated that approximately 1,300 bank cubic yards of soil would be removed, and that the excavated soil would be transported to Columbia Ridge Landfill in Arlington, Oregon (a Toxic Substances Control Act [TSCA]/RCRA Subtitle C landfill) for disposal.

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[5] Method A Soil Cleanup Levels for Industrial Properties are listed in Table 745-1 of WAC 173-340. The industrial cleanup level for PCB Mixtures is 10 mg/kg, based on applicable federal law (40 CFR 761.61). This value may be used as an industrial cleanup level only if the PCB contaminated soils are capped and the cap maintained as required by 40 CFR 761.61.

Physical constraints within Argo Yard and the east side of PSC's property, including the HCIM barrier wall, active rail lines, subsurface utilities, and existing buildings, would prevent the removal of all vadose zone soil impacted by PSC RCRA facility releases. UPRR prohibits excavation within 12 feet of the centerline of an active railroad track (unless track removal and replacement are part of the scope of the project) and may require shoring for excavations outside this area. Therefore excavation and soil removal would be limited to areas at least 12 feet from the centerline of an active track. The structural integrity of the HCIM barrier wall and buildings would be protected by maintaining a minimum 5-foot buffer around the barrier wall. In addition, excavation sidewall slopes of 1.5:1 (horizontal to vertical) would be maintained away from the barrier wall and buildings to minimize the potential to adversely affect existing structures.

The FS assumed that confirmation soil samples would be collected from the sidewalls of the excavation at a frequency of one per 50 linear feet of excavation sidewall. Following completion of soil removal efforts, the excavation would be backfilled with clean fill and compacted.

Following excavation and backfill, protective cover would be put in place. The protective cover would be constructed of asphalt and designed to support heavy traffic typical of the UPRR Argo Yard facility. The purpose of the cover would be to minimize the potential for direct contact with affected soil, limit erosion of affected soil, and to promote runoff. The cover would not be intended to provide the functions of a landfill cap and would not be designed or constructed as a landfill cap.

Alternative OA-2 would include soil vapor extraction (SVE) to address vadose zone soils within the western part of PSC's old west field. The SVE system would be installed in the accessible area between the HCIM barrier wall and the SAD building, as described in a previous report (Geomatrix, 2006e). Emissions would be controlled using a catalytic oxidizer and scrubber or alternatively with carbon. The SVE system would be operated until VOC recovery reaches asymptotic levels. Confirmation samples would be collected from soil borings completed in the vadose zone to assess attainment of cleanup levels. It was assumed that the SVE system would be operated for about 1 year.

Alternative OA-2 would also enhance anaerobic bioremediation of shallow and water table groundwater following completion of SVE. The enhanced bioremediation design (Geomatrix, 2006e) would be based on recirculation wells installed in the accessible area between the

HCIM barrier wall and the SAD building to distribute electron donor to the affected groundwater, using a single pumping/injection assembly that would be moved to each recirculation well.

In the FS groundwater monitoring for this alternative was assumed to be the same as described above for alternative OA-1. The Outside Area monitoring program for OA-2 would be similar to the program for Alternative OA-1, but might be completed in a shorter time due to more rapid groundwater restoration (20 versus 26 years).

Institutional and other controls would be incorporated into the alternative to ensure that human health and the environment are adequately protected. These controls would be the same as described for Alternative OA-1, but reliance on controls to protect workers in Argo Yard would be eased by the placement of cover in areas of residual soil contamination

This alternative would permanently reduce some soil contamination in the Outside Area through active measures. Existing cover, new cover, and institutional controls would also be relied upon to protect receptors. It is not certain that all groundwater COCs would attain their cleanup levels within a reasonable timeframe at and downgradient of the CPOC via MNA, even though this alternative would reduce chlorinated VOC mass in the vadose zone and shallower groundwater zones beneath the western part of the former west field. The estimated remediation timeframe is approximately 20 years. As with OA-1, 1,4-dioxane, vinyl chloride, and some inorganic substances may not naturally attenuate as predicted. 1,4-dioxane will only attenuate via dilution and dispersion, and there is considerable uncertainty as to its ability to attain cleanup levels throughout the Outside Area within a timeframe that is similar to timeframes associated with alternatives that supplement natural attenuation with more aggressive mass reduction.

E.3 ALTERNATIVE OA-3 – SVE, ENHANCED BIOREMEDIATION, PCB AND HOT SPOT EXCAVATION, AND SURFACE COVER

Alternative OA-3 incorporates all of the elements described above for Alternative OA-2 and adds excavation and disposal of additional “hot spot” areas within the adjacent UPRR Argo Yard (OSRA-1) that may contain elevated concentrations of COCs other than PCBs. The nature and extent of additional excavation were not known at the time the FS was prepared, so the volume of additional soil requiring excavation could only be assumed.

Investigations conducted for the Argo Yard (Geomatrix, 2006d and 2008) identified “hot spots” of localized soil contamination with elevated levels of COCs other than PCBs. After submittal of the Revised Characterization and Preferred Cleanup Approach for the Argo Yard Property report (Geomatrix, 2008), PSC and Ecology agreed that additional soil removal may be warranted than originally proposed in the FS. This is further described in Appendix F regarding the preferred cleanup approach.

The FS assumed that confirmation soil samples would be collected from the sidewalls of the excavation at a frequency of one per 50 linear feet of excavation sidewall. Following completion of soil removal efforts, the excavation would be backfilled with clean fill and compacted.

All other elements of OA-3 are the same as OA-2. Like OA-2, this alternative would permanently reduce some soil contamination in the Outside Area through active measures. In fact, it would permanently reduce additional quantities of contaminated soil. Existing cover, new cover, and institutional controls would also be relied upon to protect receptors. The estimated groundwater restoration timeframe for OA-3, like OA-2, was predicted to be 20 years.

As with OA-2, it is not certain that all groundwater COCs would attain their cleanup levels within a reasonable timeframe at and downgradient of the CPOC via MNA, even though the alternative would reduce chlorinated VOC mass in the vadose zone and shallower groundwater zones beneath the western part of the former west field. As with OA-1 and 2, 1,4-dioxane, vinyl chloride, and some inorganic substances may not naturally attenuate as predicted. 1,4-dioxane will only attenuate via dilution and dispersion, and there is considerable uncertainty as to its ability to attain cleanup levels throughout the Outside Area within a timeframe that is similar to timeframes associated with alternatives that supplement natural attenuation with more aggressive mass reduction.

E.4 ALTERNATIVE OA-4 – SVE, ENHANCED BIOREMEDIATION, PCB AND HOT SPOT EXCAVATION, SURFACE COVER, AND 1-4 DIOXANE HYDRAULIC CONTROL

Alternative OA-4 combines all of the elements of Alternative OA-3 with a groundwater recovery and treatment system designed to intercept groundwater containing 1,4-dioxane located downgradient of Denver Avenue South and prevent its further downgradient migration. Detected concentrations of 1,4-dioxane between the CPOC and Denver Avenue South are currently below cleanup levels. However, monitoring data collected from the shallow and intermediate depth intervals downgradient between Denver Avenue South and Fourth Avenue South indicate that 1,4-dioxane is present at concentrations exceeding the surface water-based cleanup level in a number of locations within both depth intervals. OA-4, therefore, proposes to install hydraulic control wells along Fourth Avenue South to prevent further migration of this contamination towards the Waterway.

Groundwater monitoring data indicate that the width of the shallow groundwater exceeding the cleanup level at Fourth Avenue South is about 1,000 feet. The width of the plume exceeding the cleanup level in the intermediate depth interval at Fourth Avenue South is about 200 feet. A preliminary analysis of hydraulic containment and capture of 1,4-dioxane-impacted groundwater was conducted using MODFLOW (USGS, 2000). Based on the MODFLOW evaluation, a single well pumping at 10 gpm would have a capture zone width of approximately 70 feet in the shallow interval and 100 feet in the intermediate depth interval. The capture zone widths were used to develop a hydraulic control groundwater recovery system layout. Based on these estimated single-well capture zones, the conceptual design for the hydraulic control groundwater recovery system included installation of seven groundwater extraction wells in the shallow interval and one well in the intermediate interval. These wells would be installed at the downgradient edge of the FS Area, along Fourth Avenue South, to prevent the further migration of 1,4-dioxane to the Duwamish Waterway.

In the FS it was estimated that the radius of influence would be established at a flow rate of 10 gpm from each well (total average flow rate of 80 gpm). It was assumed that the extraction wells would be constructed with 6-inch inside diameter, Schedule 80 PVC blank casing and stainless steel wire wrap (0.03-inch slot) well screen (15-foot screen length). The seven shallow wells would be installed to a depth of approximately 40 feet bgs, and the intermediate depth well would be installed to a depth of 80 feet bgs. Dedicated, submersible, groundwater extraction pumps would be installed in the extraction wells. Based on a preliminary assessment of the rate of migration for 1,4-dioxane, it was estimated that the hydraulic control system would be operated for a period of 10 years in order to intercept the plume of groundwater containing 1,4-dioxane at concentrations exceeding the cleanup level.

Based on the predicted average flow rate required for hydraulic control (80 gpm), it was assumed in the FS that the groundwater treatment system would be sized to treat a flow rate of 120 gpm. The public sewer does not have sufficient capacity to accommodate this flow rate, and extracted groundwater could not be discharged to the King County Metro sewers. Thus, it would be necessary to obtain a National Pollutant Discharge Elimination System (NPDES) discharge permit for direct discharge to the Duwamish Waterway. Since the discharge rate would adversely affect the capacity of the storm sewers, it was also assumed that it would be necessary to construct a new discharge line and diffuser to the Duwamish Waterway. Constituents identified in the groundwater that exceed cleanup levels (based on protection of surface water) include 1,4-dioxane, vinyl chloride, bis (2-ethylhexyl) phthalate (BEHP), iron, and manganese. So the FS assumed that it would be necessary to treat the groundwater to attain cleanup levels for these COCs prior to discharge to the Duwamish Waterway. It is estimated that the hydraulic control wells would recover approximately 23 lb of 1,4-dioxane over 10 years of operation, for an average recovery rate of 0.23 lb/year.

Of the contaminants present in groundwater recovered for hydraulic control, 1,4-dioxane is the most difficult to treat. Several treatment technologies are available for *ex situ* treatment of 1,4-dioxane, including photocatalytic oxidation systems and advanced oxidation processes that involve hydrogen peroxide and ultraviolet light (UV/Ox) or ozone oxidation (O_3/Ox). Initial capital costs for a UV/Ox system would be significantly less than for an O_3/Ox and photocatalytic oxidation systems. However, operating costs for a UV/OX system are approximately double those of the other available systems due to the significant power requirements of the UV system. For the FS's conceptual design, it was assumed that an O_3/Ox system would be used to destroy 1,4-dioxane within the extracted groundwater. The O_3/Ox unit would also remove vinyl chloride and bis (2-ethylhexyl) phthalate. Metals (iron and manganese) would be removed upstream of the O_3/Ox unit to reduce oxidant demand; metals would be removed using an ion exchanger. It was assumed that regenerant from the ion exchange system (spent brine containing iron and manganese) would to be discharged to the King County POTW. As noted above, it was assumed that a NPDES permit would be needed to allow direct discharge to the Duwamish Waterway.

Due to the extensive treatment needed for recovered groundwater and the time of operation, it would be necessary to construct a secure building to house the system. While it may be possible to purchase a parcel of land near the groundwater extraction wells for construction of the groundwater treatment system, the FS assumed that it would be necessary to install the treatment system on the PSC facility, as this property is presently available. Conveyance piping to direct recovered groundwater to the treatment system would consist of 6-inch diameter high-density polyethylene (HDPE) piping installed below grade in public rights-of-way. Discharge from the treatment system would be directed to the Duwamish Waterway via an underground 6-inch HDPE line constructed beneath public rights-of-way. An automated, programmable logic controller (PLC) based control system would be used to control pumping wells and the treatment system. It was also assumed that a new building approximately 1,500 square feet (ft^2) in area would be constructed for the treatment system.

While OA-4 would recover 1,4-dioxane at 4th Ave. S., the time required to attain groundwater cleanup levels and to complete site restoration in the Outside Area would be the same as for Alternatives OA-2 and -3, as overall restoration would depend primarily on biodegradation of other groundwater constituents between the facility and 4th Avenue South.

OA-4 incorporates all the elements described for Alternative OA-3, including enhanced bioremediation, soil vapor extraction, excavation of COC-containing soils within the UPRR Argo Yard property, and placement of additional surface cover. The number of wells, analytes, and sampling frequency for the monitoring program was assumed to be the same as described above for Alternative OA-3. In addition to monitoring described for Alternative OA-3, monitoring of the hydraulic control system would include collection of samples from each recovery well (eight samples) during each groundwater monitoring event. Samples collected from the recovery wells would be analyzed only for 1,4-dioxane.

Like OA-3, this alternative would permanently reduce some soil contamination in the Outside Area through active measures. Existing cover, new cover, and institutional controls would also be relied upon to protect receptors. The FS's estimated groundwater restoration timeframe for OA-4, like OA-2 and -3, was predicted to be 20 years.

As with OA-2 and 3, it is not certain that all groundwater COCs would attain their cleanup levels within a reasonable timeframe at and downgradient of the CPOC via MNA, even though the alternative would reduce chlorinated VOC mass in the vadose zone and shallower groundwater zones beneath the western part of the former west field. It would also capture contaminated groundwater at 4th Ave. S. and thereby more assuredly protect the river from discharges of dioxane-contaminated groundwater. As with OA-1, 2, and 3, 1,4-dioxane, vinyl chloride, and some inorganic substances may not naturally attenuate as predicted. 1,4-dioxane will only attenuate via dilution and dispersion, and there is considerable uncertainty as to its ability to attain cleanup levels between Maynard and 4th Ave. within a timeframe that is similar to timeframes associated with alternatives that supplement natural attenuation with more aggressive mass reduction.

E.5 ALTERNATIVE OA-5 – SVE, ENHANCED BIOREMEDIATION, PCB AND HOT SPOT EXCAVATION, SURFACE COVER, AND 1-4 DIOXANE HYDRAULIC CONTROL AND HOT SPOT MASS REDUCTION

Alternative OA-5 includes all of the elements described above for Alternative OA-4 and adds additional groundwater recovery and treatment to reduce the mass of 1,4-dioxane present downgradient of Denver Avenue South. Groundwater within the area with the highest concentrations of 1,4-dioxane would be recovered under this alternative. The FS's conceptual design for the additional groundwater recovery system included in Alternative OA-5 included the installation of two additional groundwater extraction wells within the shallow depth interval and one additional well in the intermediate depth interval, in addition to the wells described for Alternative OA-4.

The highest concentrations of 1,4-dioxane occur mostly to the east of 5th Avenue South in both the shallow and intermediate depth interval, based on monitoring data from November 2004 (PSC, 2005); this data set provides a more complete picture of the distribution of 1,4-dioxane than more recent monitoring data. The highest concentration of 1,4-dioxane for the intermediate depth interval occurs north of the area with the highest concentration in the shallow depth interval.

Similar MODFLOW analysis discussed for Alternative OA-4 was conducted during the FS to determine the capture zone widths used to develop the groundwater recovery system layout (Geomatrix, 2007b). Based on the estimated radius of influence of wells completed in the shallow and intermediate depth intervals, two shallow and one intermediate interval wells would be required to intercept the groundwater most highly impacted by 1,4-dioxane. As for Alternative OA-4, each shallow and intermediate extraction well would be pumped at approximately 10 gpm to capture and recover groundwater with the highest concentrations of 1,4-dioxane in each depth interval.

The FS assumed that the extraction wells would be constructed with 6-inch inside diameter, Schedule 80 PVC blank casing and stainless steel wire wrap (0.03-inch slot) well screen. The intermediate well would be installed to a depth of approximately 80 feet bgs, with 15 feet of screen installed from the bottom of the boring. The shallow wells would be installed to a depth of about 40 feet bgs, with a 15-foot screen placed near the bottom of the boring. Dedicated, submersible, groundwater extraction pumps would be installed in the extraction wells. The extracted groundwater would be collected, treated, and discharged as described for Alternative OA-4. The capacity of the groundwater treatment system would be increased to 165 gpm, which would provide 50% greater capacity than expected pumping volumes; the treatment process would be the same as described for Alternative OA-4. The pump testing described for Alternative OA-4 would be included in this alternative to ensure the design adequately intercepts and recovers groundwater affected by 1,4-dioxane. Based on the upgradient extent of the 1,4-dioxane plume and the estimated groundwater velocity of approximately 190 feet (ft) per year (ft/year) in the shallow depth interval and the intermediate interval west of approximately Maynard Avenue South, it is anticipated that the mass removal wells located along 5th Avenue South under Alternative OA-5 would be operated for 5 years. The total estimated recovery for the hydraulic control and mass removal systems is about 23 lb of 1,4-dioxane over the 10-year operation period.

To estimate costs during the FS it was assumed that the monitoring program described for Alternatives OA-2 and OA-3 would be included in Alternative OA-5. Additionally, groundwater samples would be collected from the downgradient recovery wells during each monitoring event. The two pump and treat wells could be monitored for 5 years, and the eight samples from the recovery wells would be analyzed for 1,4-dioxane. The monitoring frequency for the recovery wells would be the same as the frequency for the overall monitoring program, as described for Alternative OA-2.

Like OA-3 and 4, this alternative would permanently reduce some soil contamination in the Outside Area through active measures. Existing cover, new cover, and institutional controls would also be relied upon to protect receptors. The FS's estimated groundwater restoration timeframe for OA-5, like OA-2, -3, and -4, was predicted to be 20 years.

OA-5 would be more likely to result in all groundwater COCs attaining their cleanup levels within a reasonable timeframe at and downgradient of the CPOC. Like OA-4 it would also capture contaminated groundwater at 4th Ave. S. and thereby more assuredly protect the river from discharges of dioxane-contaminated groundwater. As with OA-1, 2, 3, and 4, vinyl chloride and some inorganic substances may not naturally attenuate as predicted.

APPENDIX F

Preferred Outside Area Cleanup Action

APPENDIX F

PREFERRED OUTSIDE AREA CLEANUP ACTION

Sections F.1 and F.2 below describe the preferred Outside Area cleanup option and Ecology's rationale for selecting it. The preferred alternative is not the alternative chosen by PSC in FS Technical Memorandum #5; nor is it exactly the same as any one of the six alternatives evaluated in that memorandum or discussed in Appendix E.

F.1 IDENTIFICATION AND RATIONALE FOR THE OUTSIDE AREA ACTION

The area addressed by the CAP includes the properties currently owned by PSC (the facility and the adjacent TASCO property), properties adjacent to the PSC properties that were affected by releases from the facility (Union Pacific Rail Road [UPRR] Argo Yard), Aronson, and SAD properties), and the contiguous areas affected by releases from the facility extending downgradient (west) to Fourth Avenue South). The **Outside Area** is a part of this larger east-of-4th area, and includes the contaminated soils and groundwater beyond (outside of) the subsurface barrier wall.

The comparative evaluation of the various Outside Area remedial alternatives is described in PSC's FS documents and is summarized in Section 5 of the text. Based on the evaluation performed in the FS, PSC identified Alternative OA-2 as their preferred alternative. However, PSC also agreed to conduct the additional soil excavation included in OA-3 to the extent it was cost-effective. The preferred alternative was later modified by Ecology to incorporate additional remedial components. For example, Ecology and PSC agreed to add a contingent 1,4-dioxane remedy consisting of a groundwater pump-and-treat action in the vicinity of Well CG-122-60, with the objective to capture and treat groundwater containing the highest concentrations of 1,4-dioxane.

In addition, since MNA is a major component of the remedy for the Outside Area groundwater plume, and since there is the potential that MNA by itself may not result in all COCs reaching their respective cleanup levels within a reasonable timeframe, Ecology believes a second contingent remedy should be identified in the CAP. The COCs which may not attenuate far enough or fast enough via MNA alone are probably vinyl chloride and one or more of the inorganic COCs, particularly arsenic.[1] Vinyl chloride is a degradation product of TCE and, at some other remediation sites, the sequential degradation of TCE does not continue past vinyl chloride. Within the area addressed by this CAP it appears that some vinyl chloride is degrading to ethene; however, under the anaerobic conditions prevalent in Outside Area groundwater, this degradation step can stall at vinyl chloride concentrations that are very low (low parts per billion [ppb] level) but still remain above the cleanup level. At these low concentrations, vinyl chloride may degrade more readily under aerobic conditions, particularly if electron donor concentrations are low.

Arsenic, iron, and manganese are all metals that become mobilized from soil under highly reducing conditions. Reducing conditions are prevalent in groundwater throughout the CAP area. It is expected that after the oxygen-depleting constituents within the groundwater plume have degraded, the aquifer will revert to a more natural and less reducing environment. Metals will then precipitate back into the soil matrix. However, the area above the plume is a highly developed industrial and urban area, and the aquifer may not return to reducing conditions sufficient to result in the expected attenuation (to cleanup levels). For this reason, if either vinyl chloride or the metals do not appear to be attaining cleanup levels within a reasonable timeframe (by about 2032), PSC will implement a contingent remedy. It is anticipated that such a remedy would be implemented in the vicinity of PSC's property (i.e., along Denver Avenue South) where concentrations are now highest and/or on the UPRR Argo Yard property.[2] For the purposes of establishing financial assurance, it has been assumed that this contingent remedy would be an aeration technology, such as air sparging, implemented within the shallow and intermediate depth intervals at/near Denver Avenue. This action would support the aerobic degradation of vinyl chloride and create oxidizing conditions to promote precipitation of the metals.

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[1] These are the substances -- other than 1,4-dioxane -- that Ecology believes are the most likely not to attenuate to their cleanup levels within a reasonable timeframe. A contingent action has therefore been included in the CAP to address these particular COCs. This does not mean that other groundwater COCs may not attain their cleanup levels within a reasonable timeframe. This is also possible. If COCs other than vinyl chloride or redox-sensitive metals fail to attain cleanup levels within a reasonable timeframe, and these COCs cannot be effectively remediated via the air sparging contingency action, a new or supplemental action will need to be considered.

[2] As noted earlier, vinyl chloride concentrations have been, and continue to be, elevated at well CG-104-I. This well is located a few feet outside the barrier wall and is screened in the Intermediate Zone. The vinyl chloride concentration detected at this location in February 2009 was 6100 µg/l.

The final cleanup action for the Outside Area therefore includes both actions and contingent actions. It contains the following elements.[3]

- An SVE system, installed and implemented between the barrier wall and the SAD building in the western part of the former west field. This action was a part of PSC's Alternative OA-2 through 5, and has already been presented to Ecology, and approved, in an engineering design report (Geomatrix, 2006e).

- An SVE system, installed and implemented on portions of the UPRR Argo Yard property (areas north and northeast of the former north field) to address releases of volatile COCs, including Stoddard solvent, that have contaminated soils.

- MNA of groundwater contamination, conducted in conjunction with long term performance monitoring (as described in Alternative OA-1 and as a component of all OA alternatives evaluated in the FS).

- The VIAM program, maintained until water table zone groundwater VOCs in the Outside Area meet cleanup levels. This was a component of all five FS Outside Area alternatives.

- Excavation and off-disposal of contaminated soils within the part of Argo Yard included in PSC's FS. An approach for the cleanup action for this area was initially developed in the FS, but was further refined separately (Geomatrix, 2008). Excavation and off-site disposal of soils affected with PCBs and other COCs will be performed at four areas adjacent to or near the PSC and UPRR property boundary (Geomatrix, 2008). This excavation will also result in the removal of the majority of soil COCs in these areas.[4]

- Enhanced bioremediation of groundwater on the UPRR Argo Yard property by placing electron-donor material in the soil excavation areas prior to backfill.

- An asphalt cap, placed over contaminated soils located on the facility but outside the barrier wall. Some contaminated soils in Argo Yard will also be paved. This cover will prevent direct contact and limit erosion.

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[3] ISB in the area between the barrier wall and the SAD property, which was originally part of Alternative OA-2 and was included in the preliminary design report (Geomatrix, 2006e), was determined by Ecology to no longer be required based on the positive trends in groundwater quality during the last 2 years of monitoring (Ecology, 2007). Please see Section F.2.

[4] In January 2008 PSC submitted a report to Ecology entitled "Characterization and Preferred Cleanup Approach for Argo Yard" (Geomatrix, 2008). This report documents site characterization of soil and groundwater at Argo Yard and presents a cleanup approach for both soil and groundwater COCs above cleanup levels. In October 2008, PSC and Ecology agreed to a revised cleanup approach that included additional excavation, groundwater treatment, and a contingent remedy for Argo Yard, as described in this CAP.

- Institutional controls, as discussed in E.1, to ensure future industrial use and limit potential risks associated with subsurface work.
- Performance monitoring, as proposed in OA-1 through OA-5.
- Financial assurance to implement the remedial elements described above.

Depending on future monitoring results, it may be necessary for PSC to implement additional actions. For the purposes of the CAP and establishing an adequate amount of financial assurance, the following contingent cleanup elements were developed:

- Groundwater recovery and treatment for 1,4-dioxane using a single recovery well pumped at 20 gpm for 1.3 years located in the vicinity of Well CG-122-60; and
- Air sparging along/near Denver Avenue South and/or on the UPRR Argo Yard property.

These contingent remedy elements would not be implemented unless Ecology concluded that the cleanup action was failing to achieve groundwater cleanup levels in the Outside Area within a reasonable timeframe. Monitoring results will be reviewed on an on-going basis to determine if attenuation is occurring as expected, and if concentrations appear to be approaching cleanup levels within the following timeframes:

- 5 years, for 1,4-dioxane
- 22 years, for chlorinated organic COCs for all aquifer zones.

Although no specific timeframe has been established for the attainment of inorganic cleanup standards, it is expected that this will be achieved within several years of organic COC attainment and a shift in groundwater geochemistry to better mirror pre-release conditions.

Under the preferred action biodegradation processes in groundwater will permanently degrade organic COCs other than 1,4-dioxane. Metals should attenuate to background levels after groundwater redox conditions return to natural (pre-release) levels following degradation of the organic COCs. The 1,4-dioxane plume present in the shallow and intermediate depth intervals is “detached” in the sense that dioxane in these zones immediately downgradient from the facility is below the cleanup level. It is expected that 1,4-dioxane concentrations will continue to attenuate as the plume migrates toward the Duwamish Waterway. Monitoring data indicate that cleanup levels for 1,4-dioxane may be achieved in the Outside Area within a reasonable timeframe by ongoing attenuation processes.

Much of the monitoring well network needed to implement the proposed Outside Area cleanup action is already in place. The current monitoring program can be modified to meet the cleanup action performance monitoring goals. Until shallow VOC concentrations in groundwater are reduced to cleanup levels, the VIAM program will ensure that indoor air quality is not unacceptably impacted by vapor intrusion.

Soils known to be contaminated by COC releases from the facility in the adjacent UPRR Argo Yard will be excavated and removed for off-site disposal, or capped. All remaining contaminated soils will be covered by pavement. SVE will then be conducted to permanently remove and destroy volatile COCs in soils on the Argo Yard property north and northeast of the former north field. It will also permanently reduce VOC concentrations in soils in the area between the HCIM barrier wall and the SAD building (which will also address VOCs potentially in soils beneath the SAD building).

The cleanup action is readily implementable; a number of the containment and monitoring components are currently in place. Although coordination will be necessary with UPRR, and the existing access agreement must be extended and modified to allow for excavation and removal of COC-impacted soil in Argo Yard, this should not pose significant difficulties.

Long-term O&M associated with the preferred alternative includes continuation of the VIAM program and assurance that mitigation systems are operating effectively. Groundwater monitoring wells will also require maintenance. In the shorter term, there will be maintenance tasks associated with operating the SVE system.

Institutional controls on the PSC and Argo Yard properties will include: deed restrictions; controls to prevent unrestricted use of the property and underlying groundwater; controls requiring the protection of workers digging below the pavement in contaminated areas; requirements for notifying future property owners that any recovered soil or groundwater may require management under Washington Dangerous Waste Rules; and (for Argo Yard), an agreement allowing PSC access to the area for cap maintenance and groundwater monitoring.

The Outside Area cleanup action will:

- attain Outside Area remediation objectives;
- prevent direct contact with contaminated soils, prevent inhalation of contaminated dust, and limit erosion in areas affected by the RCRA facility. This would be

accomplished by removing some contaminated soils in the Argo Yard, providing surface cover over contaminated soils in other areas, and by implementing institutional controls that would protect workers in areas where contaminated soils remained;

- reduce risks for future indoor Argo Yard workers due to inhalation of vapors by establishing vapor intrusion-related institutional controls;
- protect human and ecological receptors at the Waterway from releases which have contaminated groundwater. Remediation levels (RLs) are currently being attained at the proposed CPOC;
- reduce COC concentrations to achieve groundwater cleanup levels at the proposed CPOC and downgradient within the Outside Area. This reduction would be accomplished within a reasonable restoration timeframe. If the reduction to cleanup levels does not appear to be occurring within a reasonable timeframe, and the cause is poor remedy (MNA) performance, PSC will implement new actions (such as the two contingent remedies financial assurance has been provided for);
- not adversely affect existing land use within the Outside Area, and utilize a readily implementable remediation approach that can be fully constructed and implemented with minimal delays for engineering, permitting, and construction;
- be fully compatible with existing interim measures and with the proposed cleanup action for the HCIM Area;
- use proven, robust technologies to permanently destroy soil and groundwater VOC mass;
- create minimal short-term risks and have minimal potential for exposing the public to COCs during implementation of the cleanup; and,
- be unlikely to interfere with on-going or future remedial measures implemented downgradient of 4th Avenue South.

The selected cleanup action must be able to meet the threshold criteria established under MTCA (WAC 173-340-360(2) and 173-340-380(1)(a)(viii)). The following subsections address each of these threshold criteria for the Outside Area.

Overall Protection of Human Health and the Environment

The Outside Area soil cleanup action – which includes excavation/off-site disposal, SVE, surface cover, and institutional controls – will be protective of human health and the environment by reducing concentrations of COCs that may contribute to groundwater contamination, preventing direct contact with soils and inhalation of dust, and ensuring that vapor intrusion mitigation systems are installed if needed. The MNA groundwater cleanup action will permanently destroy some organic COCs, and is projected to attain cleanup levels for all COCs within a reasonable timeframe. The VIAM incorporated into the cleanup action will mitigate risks associated with the inhalation pathway until cleanup levels are attained within the downgradient plume.

Compliance with Cleanup Standards

Contaminated soils will either be remediated to attain cleanup standards or will be capped. Groundwater is expected to comply with cleanup standards within a reasonable timeframe (22 years). If it appears that MNA is incapable of achieving all groundwater COC cleanup levels within a reasonable timeframe, additional actions – such as the two contingent remedies included in the CAP – shall be implemented.

Compliance with Applicable State and Federal Laws

The final cleanup action will be designed and implemented so that it is fully compliant with ARARs.

Compliance Monitoring

Long-term compliance monitoring is a component of the cleanup action. The compliance monitoring program, based on the existing Pre-Corrective Action Monitoring program, will effectively determine compliance with cleanup standards.

Permanent Solutions

The cleanup action includes permanent solutions to the extent practicable. It will permanently destroy VOC mass in soils and groundwater. It will also permanently remove soils contaminated with PCBs and other substances from Argo Yard, and dispose of them in a landfill permitted and designed for such disposal. 1,4-dioxane in groundwater will not be permanently remediated (unless the contingent remedy is implemented), since attenuation will only rely upon dilution and dispersion. Likewise, elevated inorganic constituents in groundwater will not be remediated via a permanent solution. To the extent these chemicals are natural components of the aquifer, however, once geochemical conditions become less reducing they should revert to less mobilized states, lowering dissolved groundwater concentrations.

Reasonable Restoration Timeframe

The evaluation of restoration time in the FS balanced the urgency of achieving remediation objectives and cleanup levels with a number of factors such as the potential risks posed during the restoration timeframe, potential and existing property uses within the east-of-4th site area, the availability of alternative water supplies, the effectiveness and reliability of institutional controls (including the VIAM program), the toxicity of hazardous substances, the ability to hasten cleanup level attainment (and how fast certain alternatives could attain these levels versus other alternatives), and the costs of relatively rapid versus slower cleanup actions .

The combination of cleanup elements included in the Outside Area cleanup action achieves a reasonable restoration time by:

- relying upon natural attenuation of groundwater contamination if this process, as it is monitored, demonstrates an ability to attain cleanup standards within approximately 22 years (by 2032);[5]
- quickly removing the worst soil contamination present in Argo Yard, and disposing of these soils in an off-site landfill; and,
- applying SVE to soils in Argo Yard and in the old West Field to reduce VOC concentrations.

Many areas where groundwater COCs currently exceed their cleanup levels in the Outside Area will attain cleanup before 2032. It is expected, for example, that 1,4-dioxane concentrations throughout the Outside Area will drop to cleanup levels by 2015. TCE and vinyl chloride in some areas are already below or only marginally above cleanup levels and are expected to attenuate to their respective cleanup levels well before 2032.

Ecology believes that an Outside Area groundwater restoration period of about 22 years is justifiable for the following reasons, and under the following conditions:

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[5] Modeling performed during the FS (2006) predicted that groundwater cleanup levels could be achieved by OA-2, 3, 4, and 5 within 20 years. Later (in 2008), PSC used a more current data set to check this prediction and concluded that the estimate should be increased by about two years.

(1) The highest beneficial use of groundwater in the site area remains feed water (discharge) for the Duwamish Waterway. No efforts are initiated to use, or plan for the use of, groundwater as a drinking water source.

(2) Groundwater contamination does not pose an unacceptable threat to surface water or sediment quality in the Duwamish River. Presently, COCs have attained their RLs in the Outside Area.

(3) The vapor intrusion threat can be effectively addressed via PSC's VIAM program, and PSC continues to fund the operation, maintenance, and repair of mitigation systems needed in the Outside Area.

(4) No combination of practicable, cost-effective cleanup actions, utilizing more aggressive forms of groundwater treatment, could significantly reduce the restoration timeframe.

Consideration of Public Concerns

The proposed action was developed by assuming that the public favors a cost-effective remedy for the PSC site that will be adequately protective while being implemented, and will result in an environment that does not pose unacceptable health risks. It was based on the assumption that the public concern regarding contaminated groundwater in the Outside Area was primarily: a) its eventual discharge to the Duwamish Waterway (and the possibility of contaminating the river), and b) its ability to volatilize and contaminate indoor air. The proposed action addresses these concerns.

F.2 ELEMENTS NOT INCLUDED IN ECOLOGY'S OUTSIDE AREA ACTION

In Ecology's July 3, 2007 letter to PSC, responding to FS Tech Memo #5, the Department identified remedial elements we believed should be included in the Outside Area preferred alternative. We subsequently decided that one of these elements need not be included in the cleanup action proposed to the public in the draft CAP. The following discussion summarizes this element and Ecology's rationale for deciding it could be omitted from the proposed cleanup action.

West Field Groundwater Action

Ecology had asked PSC to include an enhanced bioremediation action (ISB) for groundwater in the former west field in the company's preferred Outside Area alternative. The action was proposed in FS alternatives OA-2 through 5 and PSC agreed to implement it as part of the final cleanup action. However, in December 2007 Ecology's proposed Outside Area cleanup action only included SVE for this area, ISB was omitted.

This ISB action had been conceived prior to the preparation of FS Tech Memo #5, and a "50% Engineering Design Report" describing how it would be implemented had been prepared and generally approved in 2006. The action was perceived as necessary at the time to respond to unexpected increases in VOC concentrations at well 149, immediately outside the barrier wall. Over the past year, however, groundwater VOC concentrations at well 149 have decreased significantly. In February 2008 samples from well 149WT indicated that TCE concentrations were 19 µg/l and vinyl chloride concentrations were 16 µg/l. These concentrations are both above cleanup levels, but below RLs. At this time Ecology no longer believes, in fact, that the cost of this ISB component of the action is warranted. In establishing alternatives OA-2 and 3 as the basis of our preferred remedy, therefore, Ecology has limited proposed actions in the southwest corner of the former west field to SVE.

APPENDIX G

Former Amalgamated Sugar Company Property
Phase I Review

Geomatrix

Memorandum

TO: Andy Maloy, PSC
FROM: Tasya Gray, Geomatrix
CC: Project File
DATE: April 9, 2007
PROJ. NO.: 8770
PROJ. NAME: PSC Georgetown
SUBJECT: **Former Amalgamated Sugar Company Property Phase I Review**

Geomatrix Consultants, Inc. (Geomatrix) gathered available environmental information related to the former Amalgamated Sugar Company (TASCO) property, located west of the former PSC Georgetown facility and currently owned by Philip Services Corporation (PSC).

The following resources were used:

- Phase I Environmental Site Assessments (Braun, 1995 and 1996);
- Files obtained from the Washington State Department of Ecology (Ecology) through a public records request;
- Polk City Directories (1927, 1928, 1937, 1939, 1940, 1943-44, 1948-49, 1951, 1953, 1955, 1957, 1959, 1961, 1963, 1965, 1967, 1969, 1971, 1973, 1977, 1979, 1981, 1983, 1985, 1987, 1989, and 1994) (Polk);
- Aerial Photographs (1936, 1941, 1956, 1960, 1961, 1965, 1969, 1970, 1974, 1977, 1980, 1985, 1989, 1995, 2001, and 2002) (Aerial);
- Sanborn Fire Insurance Maps (1917, 1929, 1949, 1960, and 1967) (Sanborn);
- Kroll Maps (1912 to 1920, 1940 to 1960, and 1970s) (Kroll);
- King County Plat Map;
- Puget Sound Regional Archives tax folio copies (requested for tax parcels 3868400016, 5084400085, 5084400124, 1722800206, 1722800214, and 3868400050) (Archives);
- Historical photographs from the Museum of History and Industry (MOHAI) in Seattle;

One Union Square, 600 University Street, Suite 1020
Seattle, Washington 98101-4107
Tel 206.342.1760
Fax 206.342.1761
www.geomatrix.com

- City of Seattle Department of Planning and Development (DPD) records including plans, permits, sewer cards, and geotechnical records (sewer card or Seattle); and

- Seattle Public Library business catalog files (SPL).

Former underground storage tanks were the only potential environmental threat identified. The records described the following historical tanks used at the TASCO property:

- Tank 1 – 1,000-gallon diesel tank;

- Tank 2 – 1,000-gallon gasoline tank (co-located with Tank 1); and

- Tank 3 – 1,500-gallon diesel tank;

All tanks were used beginning in the 1960s (Tanks 1, 2, and 3). Tank Closure forms for all three tanks are on record at Ecology and included in Attachment A. Tank 3 went through Permanent Closure in 1991. Tanks 1 and 2 went through Permanent Closure in 1993. Tank removal was confirmed in the closure documentation for all three tanks.

Additional characterization information was documented during closure of the following tanks:

> **Tanks 1 & 2 –** Soil samples were collected from the bottom and side walls of the tank removal excavation and analyzed for BTEX and total petroleum hydrocarbons. One sample was also analyzed for total lead. The only detected analyte was total petroleum hydrocarbons as diesel at a concentration of 57 mg/kg total.
>
> **Tank 3 –** Soil samples were collected from the bottom and sidewall of the tank removal excavation and analyzed for BTEX and total extractable petroleum hydrocarbons. Results showed concentrations below 20 parts per million (ppm).

Tanks 1 and 2 are depicted in a hand-drawn map found in the Ecology files and included in Attachment B. Additional site maps attained from the Seattle DPD records show an UST in this same approximate location. These maps are also included in Attachment B. Location information was not available for Tank 3.

REFERENCES

Braun Intertec Corporation, 1995, Phase I Environmental Site Assessment, Terminal, 5400 Denver Avenue, Seattle, Washington, Prepared for: Doherty, Rumble & Butler, P.A., August 11.

Braun Intertec Corporation, 1996, Phase I Environmental Site Assessment Supplement, Prepared for: Jones, Waldo, Holbrook & McDonough, November 15.

ATTACHMENTS

Attachment A	Site Check/Site Assessment Forms
Attachment B	Site Maps

ATTACHMENT A

Site Check/Site Assessment Forms

TANKS 1 & 2

Permanent Closure/Change-In-Service Checklist

U0026899

The purpose of this form is to certify the proper closure/change-in-service of underground storage tank (UST) systems. These activities must be conducted in accordance with Chapter 173.360 WAC. Washington State UST rules require the tank owner or operator to notify Ecology in writing 30 days prior to closure or change-in-service of tanks. This must be done by completing the 30 Day Notice form (ECY 010-155).

This Permanent Closure Checklist shall be completed and signed by a Licensed Decommissioning Supervisor. The supervisor shall be on site when all tank permanent closure/change-in-service activities are being conducted. The firm which employs the licensed supervisor shall also be licensed by the Washington State Department of Ecology as a Service Provider. If any of the activities listed below have been supervised by a different licensed supervisor, a separate checklist must be filled out and signed by the licensed supervisor performing those activities.

For further information about completing this form, please contact the Department of Ecology UST Program.

A separate checklist must be completed for each UST system (tank and associated piping), except that UST systems at one site may be reported together by completing page 2 of this form separately for each system. The completed checklist should be mailed to the following address within 30 days of the completion of the closure or change-in-service.

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

JUN 7
UNDERGROUND STORAGE TANK

1. UST SYSTEM OWNER AND LOCATION

Clean Closure
follow up

Site Owner/Operator:

Owners Address: Street P.O. Box
City Zip Code

Telephone: ( )

Site ID Number (on invoice or available from Ecology if tank is registered):

Site/Business Name: AMALGMATED SUGAR CO

Site Address: 5400 DENVER AVE S (Street) KING (County)
SEATTLE (City) WA (State) 98108 (Zip Code)

2. TANK PERMANENT CLOSURE/CHANGE-IN-SERVICE PERFORMED BY:

Firm: JOE HALL CONST INC License Number: 5000028

Address: 1317 54TH AVE E. (Street) P.O. Box
FIFE (City) WA (State) 98424 (Zip Code)

Telephone: (206) 922-6815

Licensed Supervisor: MATT ERB Decommissioning License Number: W001398

This page must be completed separately for each tank permanently closed (decommissioned) or change-in-service at the site. For additional tanks you may photocopy this form prior to completing.

3. TANK CLOSURE/CHANGE-IN-SERVICE INFORMATION

1. Tank ID Number (as registered with Ecology): n/a
2. Year installed: n/a
3. Tank capacity in gallons: 1000
4. Date of last use: n/a
5. Last substance stored: Deisel
6. Date of closure/change-in-service: 5-20-93
7. Type of closure: Closure with Tank Removal ☒ In-place Closure ☐ Change-in-Service ☐
8. If in-place closure is used, the tank has been filled with the following substance:
9. If change-in-service, indicate new substance stored in tank:
10. Local permit(s) (if any) obtained from: Seattle Fire Department

Always contact local authorities regarding permit requirements.

11. Has a site assessment been completed? Yes ☒ No ☐

Unless an external release detection system is operating at the time of closure or change in service, and a report is provided as specified in W 173-360-390, a site assessment must be conducted. This site assessment must be conducted by a person registered with the Department of Ecology to perform site assessments. Results of the site assessment must be included with the Site Assessment Checklist (ECY 010-158).

4. CHECKLIST

Each item of the following checklist shall be initialed by the licensed supervisor whose signature appears below.	Yes	No	N
1. Has all liquid been removed from product lines?	m.E.		
2. Has all product piping been capped or removed?	m.E.		
3. Have all non-product lines been capped or removed?	m.E.		
4. Have all liquid and accumulated sludges been removed from the tank?	m.E		
5. Has the tank been properly purged or inerted?	m.E.		
6. Have the drop tube, fill pipe, gauge pipe, pumps and other tank fixtures been removed?	m.E.		
7. Have all tank openings been plugged or capped? NOTE: One plug should have 1/8 inch vent hole.	m.E.		
8. Have all sludges removed from the tank been designated and disposed of in accordance with the state of Washington's dangerous waste regulations (Chapter 173-303 WAC)?	m.E.		
9. If removed, was tank properly labeled and disposed of in accordance with all applicable local, state and federal regulations?	m.E.		

*Item not applicable

I hereby certify that I have been the licensed supervisor present on site during the above listed permanent closure activities an the best of my knowledge they have been conducted in compliance with all applicable state and federal laws, regulations and procedures pertaining to underground storage tanks.

Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

5-20-93
Date

Matt E
Signature of Licensed Supervisor

5. ADDITIONAL REQUIRED SIGNATURES

5-21-93
Date

Dave Dunn
Signature of Licensed Service Provider (firm) Owner or Authorized Representative

6-1-93
Date

Bruce C. Goodnow - Mgr.
Signature of Tank Owner or Authorized Representative

White Satin

THE AMALGAMATED SUGAR COMPANY
5400 DENVER AVE. - SEATTLE, WASHINGTON 98108

BRUCE GOODNOW
MANAGER

PHONE (206) 762-0622
FAX (206) 767-4310

NW

TANK

e/Decommission Tanks

cology with notice of intent to close/decommission an UST. It ust be signed and dated by either the owner/operator of the is could be the firm contracted to do the work.) Ecology will ommissioning activities may commence.

r questions on completing this form please call (206) 459-6293.

lease type or use ink.

he completed checklist should be mailed to:

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

RECEIVED
FEB 18 1993
DEPT OF ECOLOGY

DEPARTMENT OF ECOLOGY
UNDERGROUND STORAGE TANKS
FEB 10 1993

TANK OWNER AND LOCATION

ST Owner/Operator: The Amalgamated Sugar Co.

wners Mailing Address: 5400 - Denver Ave So.
Street / P.O. Box
Seattle, City / Wash., State / 98108, ZIP Code

lephone: (206) 762-0622

te ID Number (on invoice or available from Ecology if tank is registered): #004313

te/Business Name: The Amalgamated Sugar Co.

te Address: 5400 - Denver Ave., Street / King, County
Seattle, City / Wash., State / 98108, ZIP Code

TANK PERMANENT CLOSURE TO BE PERFORMED BY (if known):

rm: Joe Hall Construction, Inc. LIC #500042

ddress: [illegible] Pacific Hwy E #276, Street / P.O. Box
Fife, City / WA, State / 98424-2627, ZIP Code

lephone: (206) 922-6815 Contact Name: Dave Kilssor

TANK INFORMATION

Tank Identification	Approx. Closure Date	Tank Capacity (gallons)	Tank Age (years)	Last Substance Stored
1		1,000 gallons	60's ?	Gas
2		1,000 gallons	60's ?	Diesel (No 2

SIGNATURE OF TANK OWNER/OPERATOR OR AUTHORIZED REPRESENTATIVE:

Bruce L. Goodnow, Signature
Manager, Title
2-9-93, Date

CY 061-135 11/90

This page must be complete[illegible]eparately for each tank permanently closed (decommissioned) or change-in-service at the site. For ad[illegible]onal tanks you may photocopy this fo[illegible]prior to completing.

3. TANK CLOSURE/CHANGE-IN-SERVICE INFORMATION

1. Tank ID Number (as registered with Ecology): N/A
2. Year Installed: N/A
3. Tank capacity in gallons: 1,000 gallons
4. Date of last use: N/A
5. Last substance stored: Gasoline
6. Date of closure/change-in-service: 5-20-93
7. Type of closure: Closure with Tank Removal ☒ In-place Closure ☐ Change-In-Service ☐
8. If in-place closure is used, the tank has been filled with the following substance:
9. If change-in-service, indicate new substance stored in tank:
10. Local permit(s) (if any) obtained from: Seattle Fire Department

Always contact local authorities regarding permit requirements.

11. Has a site assessment been completed? Yes ☒ No ☐

Unless an external release detection system is operating at the time of closure or change in service, and a report is provided as specified in WA 173-360-390, a site assessment must be conducted. This site assessment must be conducted by a person registered with the Department of Ecology to perform site assessments. Results of the site assessment must be included with the Site Assessment Checklist (ECY 010-158).

4. CHECKLIST

Each item of the following checklist shall be initialed by the licensed supervisor whose signature appears below.

	Yes	No	N/
1. Has all liquid been removed from product lines?	M.E.		
2. Has all product piping been capped or removed?	M.E.		
3. Have all non-product lines been capped or removed?	ME		
4. Have all liquid and accumulated sludges been removed from the tank?	ME.		
5. Has the tank been properly purged or inerted?	ME		
6. Have the drop tube, fill pipe, gauge pipe, pumps and other tank fixtures been removed?	ME.		
7. Have all tank openings been plugged or capped? NOTE: One plug should have 1/8 inch vent hole.	M.E.		
8. Have all sludges removed from the tank been designated and disposed of in accordance with the state of Washington's dangerous waste regulations (Chapter 173-303 WAC)?	M.E.		
9. If removed, was tank properly labeled and disposed of in accordance with all applicable local, state and federal regulations?	M.E		

*Item not applicable

I hereby certify that I have been the licensed supervisor present on site during the above listed permanent closure activities and the best of my knowledge they have been conducted in compliance with all applicable state and federal laws, regulations and procedures pertaining to underground storage tanks.

Persons submitting false information are subject to penalties under Chapter 173-360 WAC.

5-20-93
Date

Matt Eb
Signature of Licensed Supervisor

5. ADDITIONAL REQUIRED SIGNATURES

5-21-93
Date

Dan Pusser
Signature of Licensed Service Provider (firm) Owner or Authorized Representative

6-1-93
Date

Bruce L. Goodnow
Signature of Tank Owner or Authorized Representative

804313
U0006899
NW

UNDERGROUND STORAGE TANK
Site Check/Site Assessment Checklist

The purpose of this form is to certify the proper investigation of an UST site for the presence of a release. These activities shall be conducted in accordance with Chapter 173.360 WAC. A description of the various situations requiring a site check or site assessment is provided in the guidance document for UST site checks and site assessments.

This Site Check/Site Assessment Checklist shall be completed and signed by a person registered with the Department of Ecology to perform site assessments.

Two copies of the results of the site check or site assessment should be included with this checklist according to the reporting requirements in the guidance document for UST site checks and site assessments.

For further information about completing this form, please contact the Department of Ecology UST Program.

The completed checklist should be mailed to the following address:

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

DEPARTMENT OF ECOLOGY
UNDERGROUND STORAGE TANK
JUN 7 1993

1. UST SYSTEM OWNER AND LOCATION

UST Owner/Operator: Amalgamated Sugar Co

Owners Address: 5400 Denver Ave S (Street) (P.O. Box)

Seattle (City) WA (State) 98108 (ZIP-Code)

Telephone: (206) 762-0622

Site ID Number (on invoice or available from Ecology if tank is registered):

Site/Business Name: Amalgamated Sugar Co

Site Address: 5400 Denver Ave. S. (Street) King (County)

Seattle, (City) WA (State) 98108 (ZIP-Code)

2. SITE CHECK/SITE ASSESSMENT CONDUCTED BY:

Registered Person: Dan Marsh

Address: 1209 Farallone (Street) (P.O. Box)

Seattle (City) WA (State) 98466 (ZIP-Code)

Telephone: (206) 565 5097

3. TANK INFORMATION

1. Tank ID Number (as registered with Ecology): 004313 2. Year installed: 1960'S ?

3. Tank capacity in gallons: 1,000 4. Last substance stored: Gasoline

4. REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

☐ Investigate suspected release due to on-site environmental contamination

☐ Investigate suspected release due to off-site environmental contamination

☐ Extend temporary closure of UST system for more than 12 months

☐ UST system undergoing change-in-service

☐ UST system permanently closed-in-place

☑ UST system permanently closed with tank removed

☐ Required by Ecology or delegated agency for UST system closed before December 22, 1988

☐ Other (describe):

5. CHECKLIST

Each item of the following checklist shall be initialed by the person registered with the Department of Ecology whose signature appears below.

	Yes	No
1. Has the site check/site assessment been conducted according to applicable procedures specified in the UST site check/site assessment guidance issued by the Department of Ecology?	✓ DM	
2. Has a release from the UST system been confirmed? *NOTE: Owners/operators must report all confirmed releases to the Department of Ecology or delegated agency within 24 hours.*		✓ DM
3. Are the results of the site check/site assessment enclosed with this checklist? *NOTE: Two copies of the site check/site assessment results must be submitted to the Department of Ecology according to the reporting requirements specified in the UST site check/site assessment guidance.*	DM ✓	

I hereby certify that I have been in responsible charge of performing the site check/site assessment described above. Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

20 May 93
Date

D. Marsh
Signature of Person Registered with Ecology

6. OWNER'S SIGNATURE

6-1-93
Date

Bruce Goodnow - Mgr.
Signature of Tank Owner or Authorized Representative

ECY 010-156 (12/90)

NW

THE AMALGAMATED SUGAR COMPANY
5400 DENVER AVE. - SEATTLE, WASHINGTON 98108

BRUCE GOODNOW
MANAGER

PHONE (206) 762-0622 FAX (206) 767-4310

TANK
e/Decommission Tanks

cology with notice of intent to close/decommission an UST. It ust be signed and dated by either the owner/operator of the is could be the firm contracted to do the work.) Ecology will ommissioning activities may commence.

questions on completing this form please call (206) 459-6293.

lease type or use ink.

The completed checklist should be mailed to:

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

RECEIVED
FEB 18 1993
DEPT. OF ECOLOGY

TANK OWNER AND LOCATION

ST Owner/Operator: The Amalgamated Sugar Co.

wners Mailing Address: 5400 - Denver Ave So.
Street P.O. Box

Seattle Wash. 98108
City State ZIP-Code

DEPARTMENT OF ECOLOGY
UNDERGROUND STORAGE TANKS
FEB 10 1993

elephone: (206) 762-0622

ite ID Number (on invoice or available from Ecology if tank is registered): #004313

ite/Business Name: The Amalgamated Sugar Co.

ite Address: 5400 - Denver Ave. King
Street County

Seattle Wash. 98108
City State ZIP-Code

TANK PERMANENT CLOSURE TO BE PERFORMED BY (if known):

irm: Joe Hall Construction, Inc. LIC #[illegible]

ddress: [illegible] Pacific Hwy E #276
Street P.O. Box

Fife WA 98424-2627
City State ZIP-Code

elephone: (206) 922-6615 Contact Name: Dave [illegible]

TANK INFORMATION

Tank Identification	Approx. Closure Date	Tank Capacity (gallons)	Tank Age (years)	Last Substance Stored
1		1,000 gallon	60's ?	Gas
2		1,000 gallons	60's ?	Diesel (No 2

SIGNATURE OF TANK OWNER/OPERATOR OR AUTHORIZED REPRESENTATIVE:

Bruce L. Goodnow Manager 2-9-93
Signature Title Date

TANK 3

UNDERGROUND STORAGE TANK
Permanent Closure/Change-In-Service Checklist

The purpose of this form is to certify the proper closure/change-in-service of underground storage tank (UST) systems. These activities must be conducted in accordance with Chapter 173.360 WAC. Washington State UST rules require the tank owner or operator to notify Ecology in writing 30 days prior to closure or change-in-service of tanks. This must be done by completing the 30 Day Notice form (ECY 010-155).

This Permanent Closure Checklist shall be completed and signed by a **Licensed Decommissioning Supervisor.** The supervisor shall be on site when all tank permanent closure/change-in-service activities are being conducted. The firm which employs the licensed supervisor shall also be licensed by the Washington State Department of Ecology as a **Service Provider.** If any of the activities listed below have been supervised by a different licensed supervisor, a separate checklist must be filled out and signed by the licensed supervisor performing those activities.

For further information about completing this form, please contact the Department of Ecology UST Program.

A separate checklist must be completed for each UST system (tank and associated piping), except that UST systems at one site may be reported together by completing page 2 of this form separately for each system. The completed checklist should be mailed to the following address within 30 days of the completion of the closure or change-in-service.

DEPARTMENT OF ECOLOGY
UNDERGROUND STORAGE TANKS

OCT 07 1991

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

①

1. UST SYSTEM OWNER AND LOCATION

Site Owner/Operator: The Amalgamated Sugar Company

Owners Address: 5400 Denver Ave. (Street) (P.O. Box)

Seattle (City) Washington (State) 98108 (ZIP-Code)

Telephone: (206) 762-0622

Site ID Number (on invoice or available from Ecology if tank is registered): DOE No. 004313

Site/Business Name: The Amalgamated Sugar Company - Seattle Terminal

Site Address: 5400 Denver Ave. (Street) King (County)

Seattle (City) Washington (State) 98108 (ZIP-Code)

2. TANK PERMANENT CLOSURE/CHANGE-IN-SERVICE PERFORMED BY:

Firm: BURLINGTON ENVIRONMENTAL CHEMPRO DIVISION License Number: S000235

Address: 7440 W. MARGINAL WAY SO. (Street) (P.O. Box)

SEATTLE (City), WA. (State) 98108 (ZIP-Code)

Telephone: (206) 682-4898

Licensed Supervisor:

Decommissioning License Number: W000998

This page must be completed separately for each tank permanently closed (decommissioned) or change-in-service at the site. For additional tanks you may photocopy this form prior to completing.

3. TANK CLOSURE/CHANGE-IN-SERVICE INFORMATION X

1. Tank ID Number (as registered with Ecology): N/A - Heating Boiler Fuel Supply
2. Year installed: Estimate 1965
3. Tank capacity in gallons: 1,500 gal.
4. Date of last use: Dec. 1989
5. Last substance stored: Diesel
6. Date of closure/change-in-service: 8/14/91
7. Type of closure: Closure with Tank Removal ☑ In-place Closure ☐ Change-in-Service ☐
8. If in-place closure is used, the tank has been filled with the following substance:
9. If change-in-service, indicate new substance stored in tank:
10. Local permit(s) (if any) obtained from: Seattle Fire Department, Permit Code 799T Code Ref. No. 79.113

Always contact local authorities regarding permit requirements.

11. Has a site assessment been completed? Yes ☑ No ☐

Unless an external release detection system is operating at the time of closure or change in service, and a report is provided as specified in WAC 173-360-390, a site assessment must be conducted. This site assessment must be conducted by a person registered with the Department of Ecology to perform site assessments. Results of the site assessment must be included with the Site Assessment Checklist (ECY 010-158).

4. CHECKLIST

Each item of the following checklist shall be initialed by the **licensed supervisor** whose signature appears below.

	Yes	No	NA*
1. Has all liquid been removed from product lines?	✓		
2. Has all product piping been capped or removed?	✓		
3. Have all non-product lines been capped or removed?	✓		
4. Have all liquid and accumulated sludges been removed from the tank?	✓		
5. Has the tank been properly purged or inerted?	✓		
6. Have the drop tube, fill pipe, gauge pipe, pumps and other tank fixtures been removed?	✓		
7. Have all tank openings been plugged or capped? NOTE: One plug should have 1/8 inch vent hole.	✓		
8. Have all sludges removed from the tank been designated and disposed of in accordance with the state of Washington's dangerous waste regulations (Chapter 173-303 WAC)?	✓		
9. If removed, was tank properly labeled and disposed of in accordance with all applicable local, state and federal regulations?	✓		

*Item not applicable

I hereby certify that I have been the licensed supervisor present on site during the above listed permanent closure activities and to the best of my knowledge they have been conducted in compliance with all applicable state and federal laws, regulations and procedures pertaining to underground storage tanks.

Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

8-16-91
Date

Signature of Licensed Supervisor

5. ADDITIONAL REQUIRED SIGNATURES

8-16-91
Date

Signature of Licensed Service Provider (firm) Owner or Authorized Representative

October 4, 1991
Date

Acting Environmental Engr. TASCO
Signature of Tank Owner or Authorized Representative

UNDERGROUND STORAGE TANK
Site Check/Site Assessment Checklist

The purpose of this form is to certify the proper investigation of an UST site for the presence of a release. These activities shall be conducted in accordance with Chapter 173.360 WAC. A description of the various situations requiring a site check or site assessment is provided in the guidance document for UST site checks and site assessments.

This Site Check/Site Assessment Checklist shall be completed and signed by a person registered with the Department of Ecology to perform site assessments.

Two copies of the results of the site check or site assessment should be included with this checklist according to the reporting requirements in the guidance document for UST site checks and site assessments.

For further information about completing this form, please contact the Department of Ecology UST Program.

The completed checklist should be mailed to the following address:

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

DEPARTMENT OF ECOLOGY
UNDERGROUND STORAGE TANKS
OCT 07 1991

4

1. UST SYSTEM OWNER AND LOCATION

UST Owner/Operator: The Amalgamated Sugar Company

Owners Address: 5400 Denver Ave. (Street) P.O. Box

Seattle (City) Washington (State) 98108 (ZIP-Code)

Telephone: (206) 762-0622

Site ID Number (on invoice or available from Ecology if tank is registered): DOE No. 004313

Site/Business Name: The Amalgamated Sugar Company - Seattle Terminal

Site Address: 5400 Denver Ave. (Street) King (County)

Seattle (City) Washington (State) 98108 (ZIP-Code)

2. SITE CHECK/SITE ASSESSMENT CONDUCTED BY:

Registered Person: PETER VANDERVELDE (BURLINGTON ENVIRONMENTA

Address: 7440 - W. MARGINAL WAY SO. (Street) P.O. Box

SEATTLE, WA. (City) (State) 98108 (ZIP-Code)

Telephone: (206) 682.4898 @ CHEMPRO DIVISION

3. TANK INFORMATION

1. Tank ID Number (as registered with Ecology): N/A - Heating Boiler Fuel Supply
2. Year installed: Estimate 1965
3. Tank capacity in gallons: 1,500 gal.
4. Last substance stored: DIESEL/OIL

4. REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

- ____ Investigate suspected release due to on-site environmental contamination
- ____ Investigate suspected release due to off-site environmental contamination
- ____ Extend temporary closure of UST system for more than 12 months
- ____ UST system undergoing change-in-service
- ____ UST system permanently closed-in-place
- ✓ UST system permanently closed with tank removed
- ____ Required by Ecology or delegated agency for UST system closed before December 22, 1988
- ____ Other (describe): ____

5. CHECKLIST

Each item of the following checklist shall be initialed by the person registered with the Department of Ecology whose signature appears below.

	Yes	No
1. Has the site check/site assessment been conducted according to applicable procedures specified in the UST site check/site assessment guidance issued by the Department of Ecology?	✓	
2. Has a release from the UST system been confirmed? *NOTE: Owners/operators must report all confirmed releases to the Department of Ecology or delegated agency within 24 hours.*		✓
3. Are the results of the site check/site assessment enclosed with this checklist? *NOTE: Two copies of the site check/site assessment results must be submitted to the Department of Ecology according to the reporting requirements specified in the UST site check/site assessment guidance.*	✓	

I hereby certify that I have been in responsible charge of performing the site check/site assessment described above. Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

8/20/91
Date

Pete Van[illegible]
Signature of Person Registered with Ecology

6. OWNER'S SIGNATURE

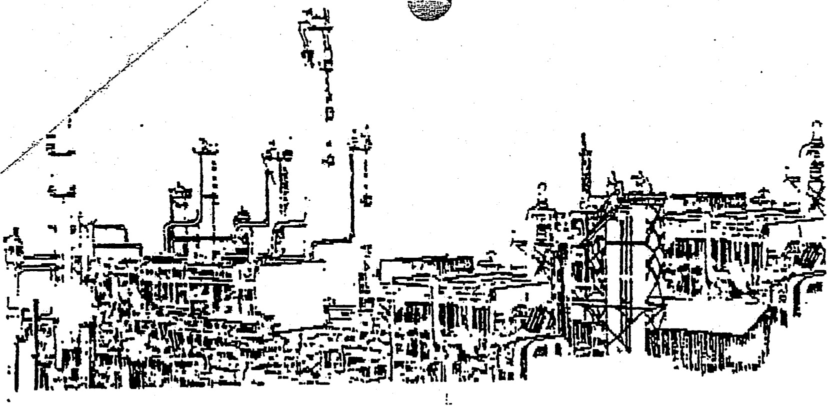
October 4, 1991
Date

John Chronic, Acting Environmental Engr. TASCO
Signature of Tank Owner or Authorized Representative

ECY 010-158 (12/90)

ATTACHMENT B

Site Maps



MARSH INDUSTRIAL RESEARCH
Site Assessing, Remediation, & Environmental Chemistry

Dan Marsh
Research Chemist

1209 Farallone
Fircrest, WA 98466
Phone (206) 565-5097

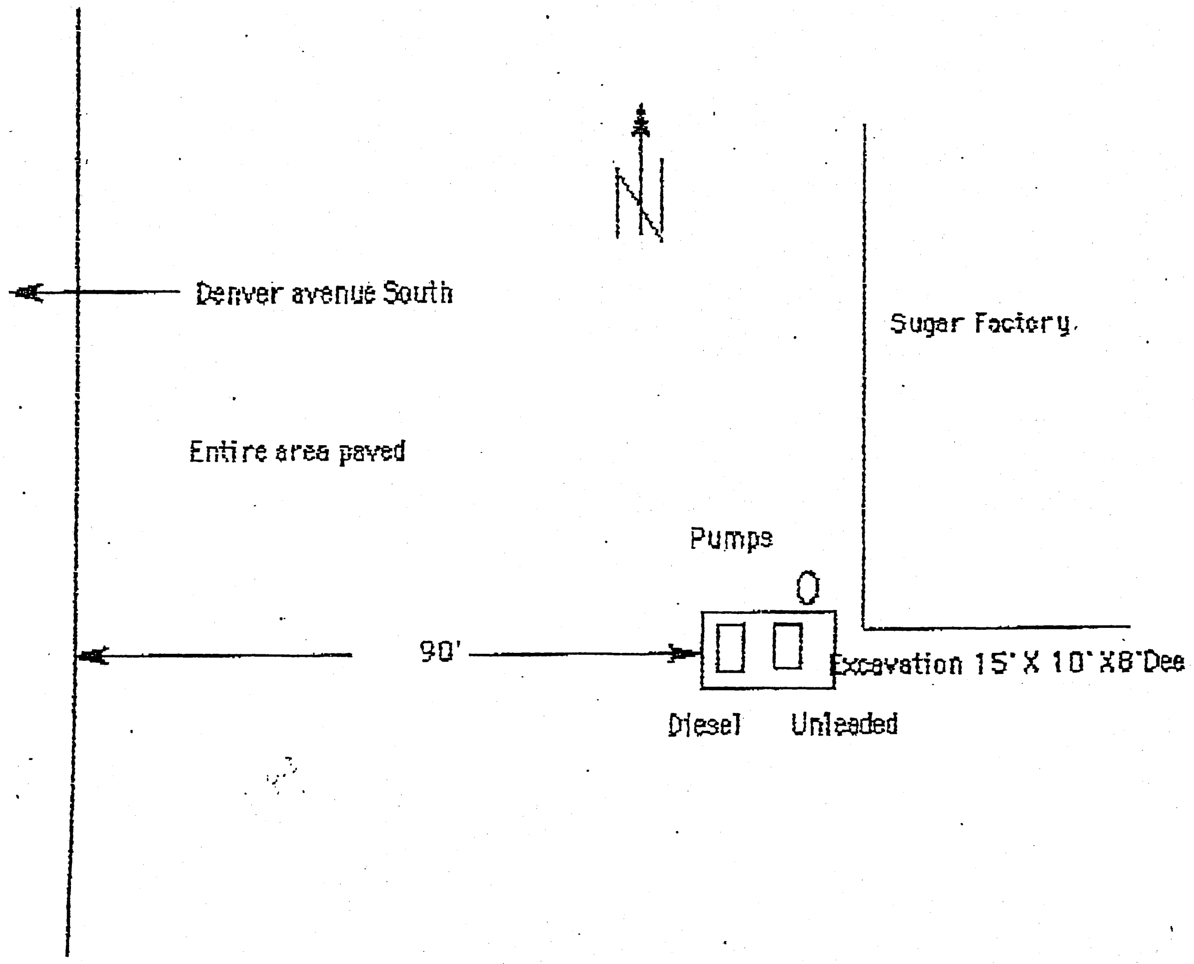
Member: Instrument Society of America

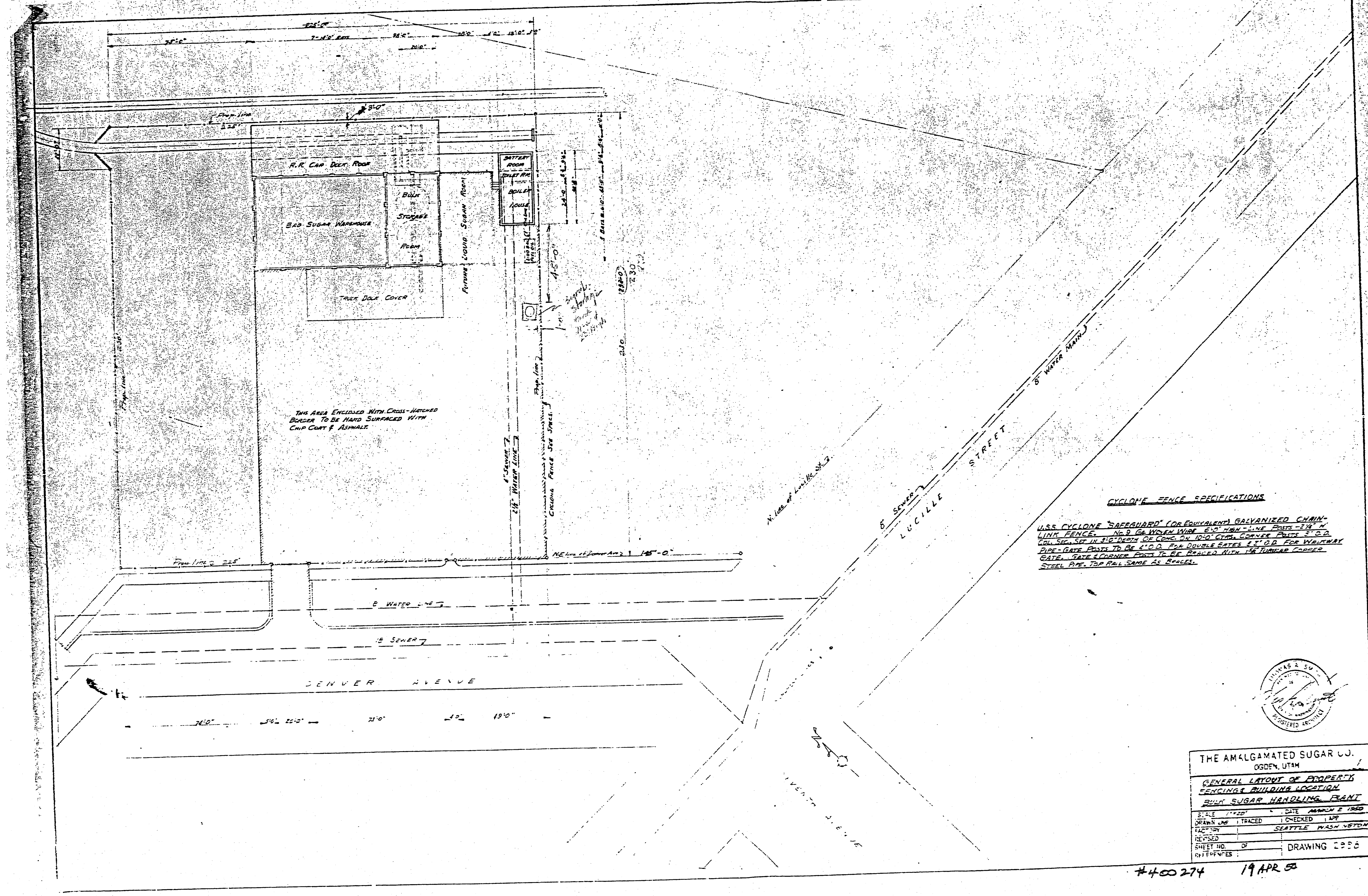
27 May 1993

Joe Hall Construction Inc.
1317 54 Ave East
Fife, WA. 98424 - 1226

Subject: G-93-057 Amalgamated Sugar soil assessment

On 20 May 1993 we removed two tanks located at 5400 Denver Avenue South. One was 1,000 Gallon Diesel and the other 1000 Gallon Unleaded. No releases were in evidence. The soil was clean around the tanks.





CYCLONE FENCE SPECIFICATIONS

U.S.S. CYCLONE "SAFEGUARD" (OR EQUIVALENT) GALVANIZED CHAIN-LINK FENCE. No. 9 GA. WOVEN WIRE 6'-0" HIGH - LINE POSTS - 2½" H COL. SEC. SET IN 3'-0" DEPTH OF CONC. ON 10'-0" CTRS. CORNER POSTS 3" O.D. PIPE - GATE POSTS TO BE 4" O.D. FOR DOUBLE GATES & 3" O.D. FOR WALKWAY GATE. GATE & CORNER POSTS TO BE BRACED WITH 1⅝" TUBULAR COPPER STEEL PIPE. TOP RAIL SAME AS BRACES.

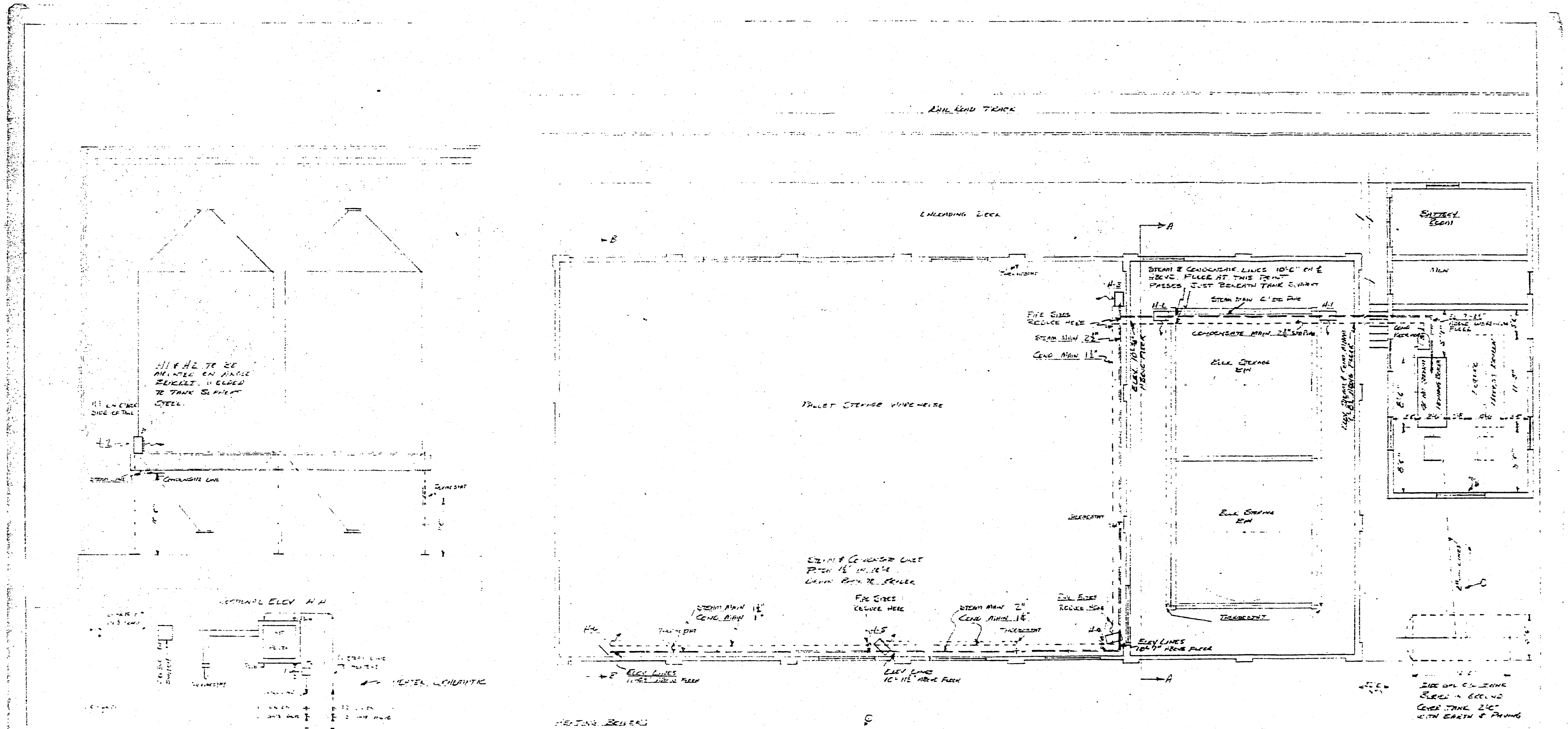
REGISTERED ARCHITECT

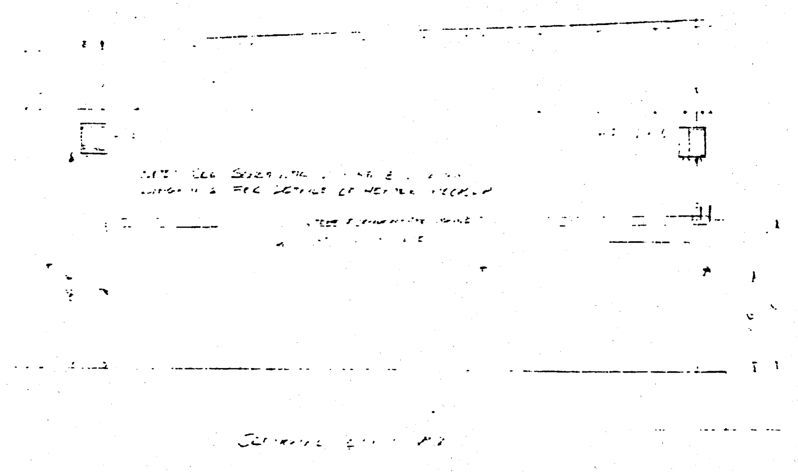
THE AMALGAMATED SUGAR CO.
OGDEN, UTAH

GENERAL LAYOUT OF PROPERTY
FENCING & BUILDING LOCATION
BULK SUGAR HANDLING PLANT

SCALE 1"=20' DATE MARCH 2 1950
DRAWN JG TRACED CHECKED APP
FACTORY SEATTLE WASHINGTON
REVISED
SHEET NO. OF
REFERENCES
DRAWING 2956

#400274 19 APR 50





HEATING BOILER:
50 HP. [illegible] HEATING BOILER [illegible]
[illegible] WORKING PRESSURE 15 PSI
RATED STEAM CAPACITY 5[illegible] SQ FT EDR
1,380 # STEAM/HR [illegible] GPH FUEL [illegible]
[illegible],000 BTU/HR [illegible]
ALL STEEL [illegible] BOILER WITH ALL FITTINGS & ACCESSORIES [illegible]
[illegible]

OIL BURNER FOR HEATING BOILER: [illegible]
[illegible] TYPE [illegible] BURNER TYPE [illegible] ETC.
[illegible]

[illegible]

OIL TANK:
[illegible]

& TWO 2" PIPE SIZE OIL LINE CONNECTIONS

CONDENSATE RECEIVER:
COMBINATION RECEIVER & PUMP ASSEMBLY WITH SIGHT GLASS, FLOAT SWITCH, PUMP & MOTOR IN ONE COMPACT INTEGRAL UNIT.
CONDENSATE TANK 20 GAL
CONDENSATE PUMP 6 GPM @ 30 PSI DISCH.
[illegible] SIZE 1" [illegible] SIZE ¾" [illegible]
[illegible] TRANE CO.
CONDENSATE RECEIVER [illegible]

UNIT HEATERS:
[illegible]
EQUIVALENT TO TRANE CO UNIT HEATERS No. 2 [illegible] BTU/HR
[illegible] 7.5 LBS COND/HR
200 @ 25 PSI
H-3, H-4, H-5, H-6
EQUIVALENT TO TRANE CO UNIT HEATER No. 5 [illegible] BTU/HR
[illegible] 5 LBS COND/HR
@ 25 PSI

[illegible] UNIT HEATER TO BE PROVIDED WITH DOUBLE POLE MANUAL FULL VOLTAGE [illegible] WITH THERMAL OVERLOAD PROTECTOR
[illegible] IS TO BE [illegible] THERMOSTAT
[illegible]

STEAM [illegible] & CONDENSATE MAIN TO BE INSULATED & WEATHERPROOFED BETWEEN BOILER HOUSE AND BULK STORAGE BLDG

*NOTE GRADE 200 FUEL OIL SEATTLE EQUIVALENT OF MEDIUM VISCOSITY INDUSTRIAL FUEL OIL BUNKER 3.

[illegible]

THE AMALGAMATED SUGAR CO.
OGDEN, UTAH

BULK SUGAR FACILITIES
HEATING SYSTEM FOR WAREHOUSE

SCALE		DATE MARCH 2 '75	
DRAWN	TRACED	CHECKED	APP.
FACTORY	SEATTLE WASH		
REVISED			
SHEET NO.	OF	DRAWING 3075	
REFERENCES			

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APPENDIX H

Cost Estimate for Cleanup Action Plan

APPENDIX H

COST ESTIMATE FOR CLEANUP ACTION PLAN

H.1 INTRODUCTION

This appendix provides the financial assurance cost estimate to construct, implement, operate, and maintain the proposed final remedy outlined in the PSC Georgetown Cleanup Action Plan (CAP). The Agreed Order describes PSC's financial responsibilities for cleanup of the facility. The Order requires that PSC continually update cost estimates used for financial assurance. These cost estimates are used to determine the amount of financial assurance PSC is required to provide. Financial assurance must sufficiently cover the long-term operations, maintenance, and monitoring associated with the cleanup action. PSC's financial assurance must sufficiently address the following:

- Construction and implementation of proposed final cleanup actions presented in the SWFS;
- Construction and implementation of the proposed contingent remedies;
- Operations and maintenance of all components of the proposed cleanup action, including existing components (hydraulic control interim measure [HCIM] and inhalation pathway interim measure [IPIM]) and contingent remedies;
- Long-term point of compliance monitoring and downgradient plume monitoring, including reporting;
- Assumed repair of the HCIM barrier wall due to failure as the result of earthquake once every 50 years; and
- 100-year cost estimating time frame.

The assumptions used to develop the cost estimate are summarized below. The cost estimate is presented on Table H-1.

H.2 GENERAL ASSUMPTIONS

- A net discount rate of 2.25% was used for this estimate. This discount rate is based on discussions with Ecology's Hazardous Waste Program's Financial Assurance Officer.

- The existing barrier wall, which is constructed of a concrete/clay mixture and will have a very long effective life, is expected to provide long-term containment of affected soil and groundwater.

H.3 GROUNDWATER MONITORING

The assumptions below regarding the number of monitoring wells, and other facets of the monitoring program, are based on a preliminary estimation of what will be required. The actual number of wells required for monitoring the performance of the CAP will be determined after the CAP has been finalized, during the Design phase of the project.

- Groundwater monitoring assumes monitored natural attenuation (MNA) will be conducted for impacted groundwater for both the HCIM and the Outside Areas using 15 CPOC and 20 downgradient monitoring wells.

- A comprehensive groundwater monitoring program will be implemented based on the use of existing groundwater monitoring wells and a revised monitoring program.

- Fifteen CPOC monitoring wells will be sampled quarterly during the first 5 years of operation and maintenance (O&M) and then semiannually for an additional 15 years. For costing purposes, we have assumed that sampling of the CPOC wells after 15 years will be reduced to annual monitoring for the remainder of the 100-year time frame for costing.

- In addition to the CPOC wells, a total of 14 downgradient (plume) monitoring wells in the SWFS Study area (East of Fourth Avenue South) and 6 monitoring wells west of Fourth Avenue South will be sampled quarterly during the first 5 years of operation and maintenance and then semiannually for an additional 17 years (until 2032), at which time cleanup levels will have been met and plume monitoring will no longer be required.

- Labor costs assume a two-person crew can sample five wells per day.

- Costs to prepare reports for each monitoring event are included in the Groundwater Monitoring costs.

H.4 REMEDIAL DESIGN

- Permitting and design costs are based on either a percentage of total costs for each task or on an estimated “Lump Sum” amount.

- The remedial design costs include capping in the HCIM and the PSC property on the south side of the barrier wall, HCIM soil vapor extraction (SVE) and dewatering, HCIM bioremediation, SVE in the area of the Stone-Drew/Ashe & Jones (SAD) property, remediation in a portion of UPRR’s Argo Yard, the 1,4-dioxane hot spot mass removal contingency, and the air sparging contingency.

H.5 HCIM PUMP AND TREAT

- Continued operation of the existing groundwater recovery and pretreatment system maintains hydraulic control through an inward groundwater gradient.
- The extraction system will operate at 10-12 gallons per minute (gpm) to draw the water table down 2 to 3 feet (ft) for a maximum of 2 years, after which time the system will be operated consistent with the original HCIM implementation plan to maintain an inward gradient with water levels on the inside of the wall maintained at least 0.5 ft below water levels on the outside of the wall.
- Annual treatment system costs are based on current system O&M costs. Treatment costs are not anticipated to increase significantly for the 2-year period of higher flows.
- Costs include producing an annual HCIM performance monitoring report, which is separate from the groundwater monitoring reports.

H.6 CAPPING

- The unpaved portion of the HCIM Area will be paved to promote stormwater runoff, minimize the potential for erosion of affected soil, and prevent direct exposure to soil COCs.
- Presently exposed soils within the Argo Yard that are affected with COCs as a result of PSC activity and that cannot be practicably excavated will be paved with asphalt.
- Affected soils located on the facility but outside the barrier wall will be paved with asphalt to prevent direct contact and limit erosion.
- For cost estimating, the areas to be capped were taken from Figure 6-1 in Technical Memorandum No. 5.
- Asphalt unit costs are based on recent paving projects.
- Remedial design costs are included in the 2008 remedial design task.
- Taxes are based on projected rates for 2008.

H.7 HCIM SOIL VAPOR EXTRACTION (SVE)

The assumptions below regarding the number of SVE wells, and other facets of the SVE system and its treatment train, are based on a preliminary estimation of what will be required. The composition of the actual system will be determined after the CAP has been finalized, during the Design phase of the project.

- An SVE system will be installed and operated after dewatering has drawn the water table down. The cost estimate assumes the SVE will run continuously for a maximum of 18 months.

- A 500 cubic foot per minute (cfm) blower, catalytic oxidizer unit, and scrubber will be used to draw soil vapor from a total of six wells.

- The cost estimate assumes six wells installed to a depth of 10 feet, constructed with 4-inch diameter polyvinyl chloride (PVC) with 5 foot screens.

- The SVE system will be inspected weekly to manage peak system performance and operational efficiency for a 6-month period, after which time the system will be inspected monthly for the remainder of the operation.

- SVE system vapors will be collected and tested monthly for permitting and operational assessment purposes.

- Initial capital costs include line items to install the SVE wells and treatment system, including permitting, design, project management, construction management, and reporting.

- O&M costs include effort for inspection, cleaning, repair, general maintenance, electricity, and costs for wastewater discharge and sampling.

H.8 HCIM *IN SITU* BIOREMEDIATION

The assumptions below regarding the number of wells, and other facets of the HCIM *in situ* bioremediation action, are based on a preliminary estimation of what will be required. The final design of this element of the cleanup action will not be completed until after the CAP has been finalized, during finalization of the Engineering Design Report. At that time a detailed procedure for implementing the action will also be established.

- *In situ* bioremediation (ISB) will be implemented following completion of SVE operations and will be operated for up to 4 years.

- Molasses (or similar carbohydrate) will be injected into a total of 32 wells. The injection well network will include 22 50-ft deep, 4-inch diameter PVC wells and 10 50-ft deep, 6-inch diameter PVC recirculation wells. Costs for all wells assume 40-foot screens.

- Two injection events will occur annually for up to 4 years. A total of 40,000 pounds of molasses will be injected into the injection well network each year.

- Cost estimates were taken from Technical Memorandum No. 5, Alternative HA-2, then modified using similar job quotes on recent projects and past experience of Geomatrix Consultants, Inc. (Geomatrix)..

- Initial capital costs include line items to install the injection wells, including permitting, design, construction management, project management, surveying, and reporting.

- Long-term costs include time and materials for biannual injections for 4 years and labor, analytical costs, and reporting costs for semiannual sampling for 6 years.

H.9 SAD SVE

The assumptions below regarding the number of SVE wells, and other facets of the SVE system and its treatment train, are based on a preliminary estimation of what will be required. The composition of the actual system will be determined after the CAP has been finalized, during the Design phase of the project.

- The SVE system for the SAD property would be installed and implemented to recover volatile organic compounds (VOCs) from the vadose zone in the area extending from the HCIM barrier wall to the southwest, beneath the SAD building.

- The SVE system will consist of wells and piping, and the piping will be connected to the central blower and air treatment system used for the HCIM SVE system.

- The SAD SVE system will extract soil vapor from three 10-ft deep, 4-inch diameter PVC wells.

- The SVE system will be inspected at the same time and frequency as the HCIM SVE system.

- Initial capital costs include line items to install the SVE wells and piping only. The blower and treatment system costs are included with the HCIM SVE costs. Costs include permitting, design, project management, and construction management.

- O&M costs are included in the HCIM SVE cost estimate.

- All costs were pulled directly from Technical Memorandum No. 5, Alternative HA-2, of the SWFS.

H.10 UNION PACIFIC RAILROAD PROPERTY

The assumptions below regarding the cleanup action on the Union Pacific Railroad (UPRR) Argo Yard property are based on a preliminary estimation of what will be required. The final design of this element of the cleanup action will not be completed until after the CAP has been finalized, during finalization of the Engineering Design Report.

- An SVE system will be installed and implemented on portions of the UPRR Argo Yard property (areas north and northeast of the former north field) to address releases of COCs, including Stoddard solvent, in soil.
- The Argo Yard SVE system will include two wells in the area north of the property line and a single well in the area east of the PSC property line.
- The SVE wells on the UPRR yard will tie into the system being built for the HCIM remedy; therefore no separate blower will be required. Piping will be installed above ground.
- Soil vapor will be extracted from three 10-ft deep, 4-inch diameter PVC wells with 5-ft screens.
- HCIM SVE O&M costs will not increase significantly for three additional SVE wells, so no O&M costs have been included in this estimate.
- Excavation and off-site disposal of PCB-affected soils will be performed on UPRR property where the highest levels of COCs were detected during PSC's investigations.
- The volume of soil to be removed was dictated by removal of PCBs to below 10 ppm (industrial cleanup level [CUL]) and secondarily for removal of VOCs at levels well above CULs and at depth (thereby a threat to groundwater). It was assumed that approximately 3,770 tons of soil will be disposed off site as solid waste and another 420 tons will be disposed of as hazardous waste.
- Contractor unit costs are based on Geomatrix engineering experience.
- Analytical unit costs are based on OnSite Environmental, Inc. (OnSite), fees and fastest possible turnaround time (24 hours for most analyses, 48 hours for toxicity characteristic leaching procedure [TCLP]).
- Groundwater monitoring costs are included in the CPOC monitoring under the groundwater task.
- Permitting, engineering design, and reporting costs will not significantly increase for the additional elements in this remedy. The costs are already included under the HCIM SVE task.

H.11 1,4-DIOXANE HOTSPOT MASS REMOVAL

The assumptions below regarding the 1,4-dioxane groundwater extraction and treatment system are based on a preliminary estimation of what will be required. The composition and operation of the actual system will be determined after the CAP has been finalized, during the Design phase of the project.

- PSC would implement this contingent remedy by installing a single extraction well and a treatment system discharging to the publicly owned treatment works (POTW) only if, by 2010, 1,4-dioxane has not shown a consistent and significant decrease in concentration at the hotspot location.
- A single well will be pumping at 20 gpm for 1.3 year, which will remove two pore volumes of groundwater from the known hot spot area.
- The extraction well will be a 60-ft deep, 6-inch diameter PVC well with a 25-foot v-wire screen.
- The treatment system will be inspected weekly for the first 3 months, then quarterly for the remainder of the treatment system operation.
- The treatment system effluent will be sampled monthly.
- Initial capital costs include installation and commissioning of the well and a peroxide/ozone treatment system, and permitting, design, project management, construction management, surveying, and reporting.
- Long-term costs include property rental for the treatment system, effluent discharge costs, treatment system consumables, labor for inspection, sampling, and maintenance, analytical costs, electricity, and reporting costs.

H.12 AIR SPARGING (AS) CONTINGENCY

The assumptions below regarding the air sparging groundwater treatment system are based on a preliminary estimation of what will be required. The composition and operation of the actual system will be determined after the CAP has been finalized, during the Design phase of the project.

- A contingency remedy would be implemented only in the event that MNA is not effective in attaining cleanup levels in 24 years (by 2032). The cost estimate for the contingent remedy assumes that failure to meet cleanup levels would occur only for vinyl chloride and/or metals such as arsenic. Both vinyl chloride and metals are expected to be treatable by implementation of a remedy that increases the dissolved oxygen content of groundwater in the area of the PSC facility, and air sparging at this point is assumed to be the preferred remedy.

- The contingent remedy would consist of 13 shallow- and 7 intermediate-depth air sparging wells installed along the outside of the barrier wall along Denver Avenue South.

- The shallow-depth wells will be 30 ft deep and the intermediate-depth wells will be 60 ft deep. Both types of wells will be 0.75-inch diameter wells with 5-foot prepacked screens. The intermediate wells will be installed with a variance from Ecology.

- The system will be inspected twice a month and be operated for a period of 2 years.

- Wells will be placed on PSC property, on City of Seattle property (Denver Avenue South), or on property with variance already in place.

- Initial capital costs include installation and commissioning of the wells and treatment system, permitting, design, project management, construction management, surveying, and reporting.

- Long-term costs include labor for inspection and maintenance, electricity, and reporting costs for 2 years.

H.13 VAPOR INTRUSION ASSESSMENT AND VAPOR INTRUSION MITIGATION SYSTEM OPERATION AND MAINTENANCE

- The existing vapor intrusion (VI) assessment approach and currently installed VI mitigation systems will continue to address the inhalation pathway until groundwater cleanup levels that are protective of VI to indoor air are achieved throughout the downgradient plume area (East of Fourth Avenue South).

- Evaluations of groundwater concentrations with respect to VI action levels (VIALs) will be performed quarterly for the next 5 years. These evaluations will decrease to semiannually (i.e., twice a year) for years 6–15 and then annually for years 16–24, based on the assumption that groundwater cleanup levels protective of VI to indoor air will be attained by year 2032 (i.e., within 24 years). Portions of the downgradient plume will likely meet cleanup levels before that time; however, this cost estimate assumes that the VI actions will continue until that time.

- The 15 VI mitigation systems that are currently installed in buildings located between the PSC Georgetown Facility and 4th Avenue South will continue to be inspected annually. Confirmation samples (i.e., groundwater, sub-slab soil gas/crawl space air, indoor air, and ambient) will be collected from three buildings annually.

- No additional buildings in the area between the PSC Georgetown Facility and 4th Avenue South will require installation of a VI mitigation system.

- Groundwater concentrations will decrease to concentrations below cleanup levels that are protective of VI to indoor air within 24 years, at which point PSC will:

    1. discontinue the regularly scheduled VI assessments of groundwater concentrations, and;
    2. shut down and remove the installed VI mitigation systems.

- The groundwater plume is expected to contract in size, and therefore cleanup levels will be attained in portions of the SWFS Area prior to 2032, the time frame for meeting cleanup levels throughout the plume area estimated in Technical Memorandum 1 of the SWFS. As a result, some of the Tier 4 inspections will not be required. Based on the current groundwater monitoring data, the plume is rapidly attenuating at the northern end along Denver Avenue South, with the exception of an area along Denver Avenue South adjacent to the SAD property. The plume is anticipated to narrow in width as well as become detached from the facility. As a result, the following assumptions were made in estimating long term costs for the Tier 4 inspections.

    1. Years 0 to 5: 15 of the 15 current locations will require a Tier 4 inspection.
    2. Years 6 to 12: 11 of the 15 locations will require a Tier 4 inspection.
    3. Years 13 to 15: 4 of the 15 locations will require a Tier 4 inspection.
    4. Years 16 to 24: 3 of the 15 locations will require a Tier 4 inspection.

- Decommissioning and removal of the 15 VI mitigation systems that are currently installed in buildings located between the PSC Georgetown Facility and 4th Avenue South are included in this cost.
- Project management costs are included for the 24-year time frame for VI assessment and VI mitigation system operation and maintenance.

H.14 PROJECT MANAGEMENT

- Project management costs are included for the duration of the 100-year time frame for costing.
- For the HCIM Area, project management costs assume a project manager will spend 10% of their time on the HCIM area duties or $20,000 per year until groundwater reaches cleanup levels outside of the barrier wall (20 years). At that point, project management time will decrease to 5% of a person's time, or $10,000 per year for the remaining 80 years.

- For the Outside Area, project management costs are assumed to be 7.5% of a project manager's time ($15,000 per year) until the completion of 1,4-dioxane treatment (6 years). Then, project management costs decrease to 5% of a person's time ($10,000 per year) for the remaining 94 years.

ATTACHMENTS:	Table H-1	Environmental Liability Calculation, Final Assurance Cost Estimate

TABLE H-1

ENVIRONMENTAL LIABILITY CALCULATION
FINANCIAL ASSURANCE COST ESTIMATE

PSC Georgetown Facility
Seattle, Washington

Task	1	2	3	4	5	6	7	8	9	10	11	12	13	Yearly Construction Total [1]	Yearly O&M Total [2]
Year	Groundwater Monitoring	Remedial Design	HCIM Pump and Treat System	HCIM Capping	HCIM SVE	HCIM ISB	SAD SVE	UPRR	1,4-Dioxane	Air Sparge Contingency	IPIM	W4FS	Project Management		
2010	$106,000	$159,000	$72,000	$0	$0	$0	$0	$0	$0	$0	$55,077	$0	$35,550	$194,600	$233,000
2011	$106,000	$0	$72,000	$42,000	$428,000	$489,000	$161,700	$688,000	$0	$0	$55,077	$75,000	$35,550	$1,919,200	$233,100
2012	$106,000	$0	$72,000	$0	$281,000	$113,000	$0	$0	$0	$0	$55,077	$0	$35,550	$0	$662,600
2013	$106,000	$0	$72,000	$0	$0	$113,000	$0	$0	$0	$0	$55,077	$0	$35,550	$0	$381,600
2014	$106,000	$0	$72,000	$0	$0	$113,000	$0	$0	$558,000	$0	$55,077	$0	$35,550	$558,000	$381,600
2015	$53,000	$0	$72,000	$0	$0	$113,000	$0	$0	$233,000	$0	$55,077	$0	$35,550	$0	$561,600
2016	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$41,559	$0	$30,550	$0	$197,100
2017	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$41,559	$0	$30,550	$0	$197,100
2018	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$191,430	$41,559	$0	$30,550	$0	$388,500
2019	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$25,895	$41,559	$0	$30,550	$0	$223,000
2020	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$41,559	$0	$30,550	$0	$197,100
2021	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$41,559	$0	$30,550	$0	$197,100
2022	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$41,559	$0	$30,550	$0	$197,100
2023	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$32,355	$0	$30,550	$0	$187,900
2024	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$32,355	$0	$30,550	$0	$187,900
2025	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$32,355	$0	$30,550	$0	$187,900
2026	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$30,550	$0	$182,500
2027	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$30,550	$0	$182,500
2028	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$30,550	$0	$182,500
2029	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$30,550	$0	$182,500
2030	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$20,550	$0	$172,500
2031	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$20,550	$0	$172,500
2032	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$20,550	$0	$172,500
2033	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$26,911	$0	$20,550	$0	$172,500
2034	$53,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$22,500	$0	$20,550	$0	$168,000
2035	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2036	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2037	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2038	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2039	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2040	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2041	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2042	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2043	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2044	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2045	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2046	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2047	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2048	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2049	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2050	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2051	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2052	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2053	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2054	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2055	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2056	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2057	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2058	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2059	$0	$0	$1,072,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$1,092,500
2060	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2061	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2062	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2063	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2064	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2065	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2066	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2067	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2068	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2069	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2070	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2071	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2072	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2073	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2074	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2075	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2076	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2077	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2078	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2079	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2080	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2081	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2082	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2083	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2084	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2085	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2086	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2087	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2088	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2089	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2090	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2091	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2092	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2093	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2094	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2095	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2096	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2097	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2098	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2099	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2100	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2101	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2102	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2103	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2104	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2105	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2106	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2107	$0	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$92,500
2108	$8,000	$0	$72,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$100,600
2109	$0	$0	$1,072,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,550	$0	$1,092,500
TOTAL 100 Yrs	$1,886,000	$159,000	$9,200,000	$42,000	$709,000	$941,000	$161,700	$688,000	$791,000	$217,300	$956,200	$75,000	$2,285,000	$2,671,800	$15,439,400

NPV 100 Years	**$1,334,400**	**$155,500**	**$3,291,000**	**$40,200**	**$672,200**	**$876,800**	**$154,700**	**$658,100**	**$703,100**	**$177,400**	**$758,100**	**$71,700**	**$1,002,000**	**NA**	**$7,369,900**

Net Discount rate: 2.25%

Financial Assurance Total [3]	**$10,041,700**

Notes:

1) Ecology reccomended that construction costs for the first 5 years were not to be included in the Net Present Value (NPV) calculations.
2) This column includes total operation and maintenance costs (O&M) for the first five years and all costs for the following 95 years, per Ecology's reccomendations.
3) The financial assurance total is based on the total construction costs of the first 5 years (with no discount rate applied) plus the NPV O&M costs for the 100 year timeline.