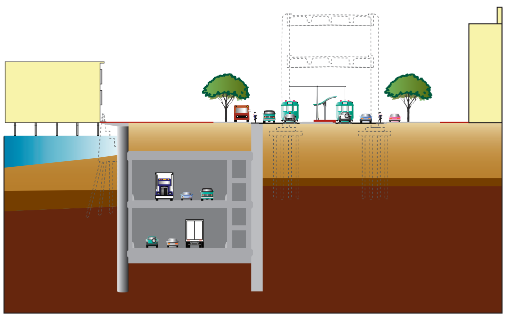
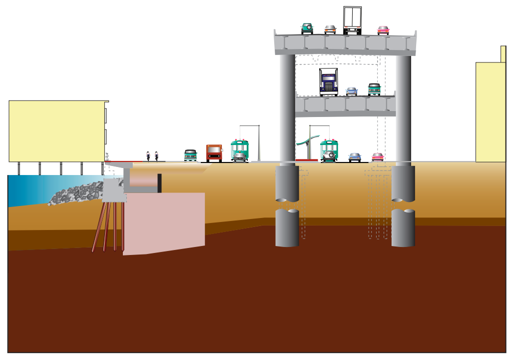
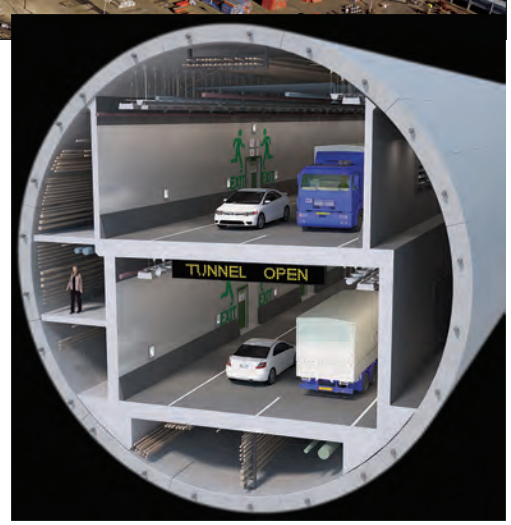
ALASKAN WAY VIADUCT REPLACEMENT PROJECT

Final Environmental Impact Statement

APPENDIX Q Hazardous Materials Discipline Report







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U.S. Department of Transportation
Federal Highway Administration

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City of Seattle

JULY 2011

Alaskan Way Viaduct Replacement Project

Final EIS

Hazardous Materials Discipline Report

The Alaskan Way Viaduct Replacement Project is a joint effort between the Federal Highway Administration (FHWA), the Washington State Department of Transportation (WSDOT), and the City of Seattle. To conduct this project, WSDOT contracted with:

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Acronyms and Abbreviations

ACM	asbestos-containing materials
AHERA	Asbestos Hazard Emergency Response Act
ASTM	ASTM International (formerly, the American Society for Testing Materials)
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CDF	controlled-density fill
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (of 1980)
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
City	City of Seattle
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSCSL	Confirmed and Suspected Contaminated Sites List
CSMP	contaminated soil management plan
cy	cubic yard
DPD	City of Seattle Department of Planning and Development
DSM	deep soil mixing
Ecology	Washington State Department of Ecology
EDR	Environmental Data Resources, Inc.
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPB	earth pressure balance
ERNS	Emergency Response Notification System
ESA	environmental site assessment
F002	A category of halogenated solvents designated as hazardous waste by the EPA, as defined in Code of Federal Regulations, Title 40, Section 261.31
FHWA	Federal Highway Administration
F-listed	On EPA's F List of hazardous wastes
GAC	granular activated carbon
gpm	gallons per minute
H_2S	hydrogen sulfide
ICR	Washington Site Register of Independent Cleanup Reports

LBP	lead-based paint
LUST	leaking underground storage tank
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act
NFRAP	No Further Remedial Action Planned
NPL	National Priorities List
NWTPH	Northwest total petroleum hydrocarbon
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PGIS	pollutant-generating impervious surface
POTW	publicly owned treatment works
ppm	parts per million
Program	Alaskan Way Viaduct and Seawall Replacement Program
project	Alaskan Way Viaduct Replacement Project
PSCAA	Puget Sound Clean Air Agency
RCRA	Resource Conservation and Recovery Act
RCRAInfo	Resource Conservation and Recovery Act Information
REC	recognized environmental condition
RP	reasonably predictable
SC	substantially contaminated
SODO	South of Downtown
SPU	Seattle Public Utilities
SR	State Route
TBM	tunnel boring machine
TCLP	Toxicity Characteristic Leaching Procedure
TSD	treatment, storage, and disposal
UST	underground storage tank
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
WAC	Washington Administrative Code
WOSCA	Washington-Oregon Shippers Cooperative Association
WSDOT	Washington State Department of Transportation

Chapter 1 INTRODUCTION AND SUMMARY

1.1 Introduction

This discipline report was prepared in support of the Final Environmental Impact Statement (EIS) for the Alaskan Way Viaduct Replacement Project (project). The Final EIS and all of the supporting discipline reports evaluate the Viaduct Closed (No Build Alternative) in addition to the three build alternatives: the Bored Tunnel Alternative (preferred), the Cut-and-Cover Tunnel Alternative, and the Elevated Structure Alternative. The designs for the Cut-and-Cover Tunnel and the Elevated Structure Alternatives have been updated since the 2006 Supplemental Draft EIS (WSDOT et al. 2006) to reflect that the section of the viaduct between S. Holgate Street and S. King Street is being replaced by a separate project, and the alignment at S. Washington Street is no longer in Elliott Bay. All three of the build alternatives are evaluated with tolls and without tolls.

The Federal Highway Administration (FHWA) is the lead federal agency for this project, primarily responsible for compliance with the National Environmental Policy Act (NEPA) and other federal regulations, as well as distributing federal funding. Per the NEPA process, FHWA was responsible for selecting the preferred alternative. FHWA has based its decision on the information evaluated during the environmental review process, including information contained in the 2010 Supplemental Draft EIS (WSDOT et al. 2010) and previous evaluations in 2004 and 2006. After issuance of the Final EIS, FHWA will issue its NEPA decision, called the Record of Decision (ROD).

The 2004 Draft EIS (WSDOT et al. 2004) evaluated five Build Alternatives and a No Build Alternative. In December 2004, the project proponents identified the Cut-and-Cover Tunnel Alternative as the preferred alternative and carried the Rebuild Alternative forward for analysis as well. The 2006 Supplemental Draft EIS (WSDOT et al. 2006) analyzed two alternatives—a refined Cut-and-Cover Tunnel Alternative and a modified rebuild alternative called the Elevated Structure Alternative. After continued public and agency debate, Governor Gregoire called for an advisory vote to be held in Seattle. The March 2007 ballot included an elevated structure alternative (differing in design from the current Elevated Structure Alternative) and a surface tunnel hybrid alternative. The citizens voted down both alternatives.

After the 2007 election, the lead agencies committed to a collaborative process (referred to as the Partnership Process) to find a solution to replace the viaduct along Seattle's central waterfront. In January 2009, Governor Gregoire, King County Executive Sims, and Seattle Mayor Nickels announced that the agencies had reached a consensus and recommended replacing the aging viaduct with a bored tunnel, which is being evaluated in this Final EIS as the preferred alternative.

1.2 Build Alternatives Overview

The Alaskan Way Viaduct Replacement Project is one of several independent projects developed to improve safety and mobility along State Route (SR) 99 and the Seattle waterfront from the South of Downtown (SODO) area to Seattle Center. Collectively, these individual projects are referred to as the Alaskan Way Viaduct and Seawall Replacement Program (the Program). See Exhibit 1-1.

Exhibit 1-1. Other Projects Included in the Alaskan Way Viaduct and Seawall Replacement Program

Project	Bored Tunnel Alternative	Cut-and-Cover Tunnel Alternative	Elevated Structure Alternative
Independent Projects That Complement the Bored Tunnel Alternative			
Elliott Bay Seawall Project	X	Included in alternative	Included in alternative
Alaskan Way Surface Street Improvements	X	Included in alternative	Included in alternative
Alaskan Way Promenade/Public Space	X	Included in alternative	Included in alternative
First Avenue Streetcar Evaluation	X	Included in alternative	Included in alternative
Elliott/Western Connector	X	Function provided[1]	Function provided[1]
Transit enhancements	X	Not proposed[2]	Not proposed[2]
Projects That Complement All Build Alternatives			
S. Holgate Street to S. King Street Viaduct Replacement Project	X	X	X
Mercer West Project	X	X	X
Transportation Improvements to Minimize Traffic Effects During Construction	X	X	X
SR 99 Yesler Way Vicinity Foundation Stabilization	X	X	X
S. Massachusetts Street to Railroad Way S. Electrical Line Relocation Project	X	X	X

1. These specific improvements are not proposed with the Cut-and-Cover Tunnel and Elevated Structure Alternatives; however, these alternatives provide a functionally similar connection with ramps to and from SR 99 at Elliott and Western Avenues.
2. Similar improvements included with the Bored Tunnel Alternative could be proposed with this alternative.

The Final EIS evaluates the cumulative effects of all the build alternatives (Chapter 7); however, direct and indirect environmental effects of these independent projects within the Program will be considered separately in independent environmental documents.

The S. Holgate Street to S. King Street Viaduct Replacement Project, currently under construction as a separate project, was designed to be compatible with any of the three viaduct replacement alternatives analyzed in this Final EIS.

1.2.1 Bored Tunnel Alternative

The Bored Tunnel Alternative (preferred alternative) includes replacing SR 99 with a bored tunnel and associated improvements, such as relocating utilities located on or under the Alaskan Way Viaduct, removing the viaduct, decommissioning the Battery Street Tunnel, and making improvements to the surface streets in the south and north areas of the bored tunnel. Broad Street would also be filled as part of the project.

The Bored Tunnel Alternative would replace SR 99 between S. Royal Brougham Way and Roy Street. The bored tunnel would convey two lanes of traffic in each direction.

Beginning at S. Royal Brougham Way, SR 99 would be a side-by-side surface roadway that would transition to a cut-and-cover tunnel. At approximately S. Dearborn Street, SR 99 would enter a stacked bored tunnel, with two southbound travel lanes on the top and two northbound travel lanes on the bottom.

The bored tunnel would continue under Alaskan Way S. to approximately S. Washington Street, where it would curve slightly away from the waterfront and then travel under First Avenue beginning at approximately University Street. At Stewart Street, it would extend north under Belltown. At Denny Way, the bored tunnel would travel under Sixth Avenue N., where it would transition to a side-by-side surface roadway at about Harrison Street.

The Bored Tunnel Alternative would also include the removal of the existing viaduct after the completion of the bored tunnel. The Battery Street Tunnel would be closed after the new bored tunnel is completed. The current proposal is to use crushed rubble from the demolition of the existing viaduct to fill the tunnel approximately two-thirds full.

There are three primary components of the Bored Tunnel Alternative: the south portal area, the bored tunnel, and the north portal area.

In the south portal areas, north- and southbound access to and from SR 99 would be provided between S. Royal Brougham Way and S. Dearborn Street. The northbound on-ramp to and southbound off-ramp from SR 99 would be built near S. Royal Brougham Way and would intersect with the East Frontage Road. Near S. Royal

Brougham Way, SR 99 would be a surface roadway. The south- and northbound lanes of the roadway would be side by side and located about 15 to 25 feet below ground surface (bgs) as SR 99 transitions to a retained cut for about 800 feet, and then a cut-and-cover tunnel section for about the first 400 feet of roadway south of the portal.

The southbound on-ramp to and northbound off-ramp from SR 99 would be built in retained cuts and feed directly into a reconfigured Alaskan Way S.

At Stewart Street, the bored tunnel would continue north under Belltown. At Denny Way, it would travel under Sixth Avenue N., where it would transition to a side-by-side surface roadway at about Harrison Street.

1.2.2 Cut-and-Cover Tunnel Alternative

The Cut-and-Cover Tunnel Alternative includes replacing the existing Alaskan Way Viaduct and Elliott Bay Seawall structures, extending just over a mile in length (approximately 5,300 feet) from S. King Street to Pine Street. The west side of the tunnel wall would replace the existing seawall.

Under the Cut-and-Cover Tunnel Alternative, no midtown on- or off-ramps would be provided, but access would be enhanced in the south portal area, where access to and from downtown would be provided at First Avenue near S. Royal Brougham Way and S. Dearborn Street. Two southbound lanes of SR 99 would emerge from the cut-and-cover tunnel to be joined by a southbound on-ramp from the Alaskan Way S. surface street that would merge into the mainline near S. Royal Brougham Way. A southbound off-ramp would diverge within the tunnel, exit onto the East Frontage Road, and continue south to the at-grade intersections at S. Royal Brougham Way and S. Atlantic Street. A northbound on-ramp would enter the tunnel portal from the East Frontage Road and merge with SR 99 traffic within the tunnel. A northbound off-ramp would be provided near S. Royal Brougham Way.

Under the Cut-and-Cover Tunnel Alternative, the Alaskan Way Viaduct structure would be removed. The Alaskan Way right-of-way would be opened up to create a large section of right-of-way between the seawall and the east side of the existing viaduct structure. This area would be available for a variety of recreational and common area uses, and the City of Seattle (City) is currently involved in an intensive design study for its use.

Between Lenora Street and the Battery Street Tunnel, SR 99 would consist of a new lowered roadway (retained cut) section with overpasses at Elliott and Western Avenues and at the Bell Street intersection. Constructing SR 99 under Elliott and Western Avenues would require a combination of retained cuts and bridges. Under Western Avenue, the northbound lanes would connect with the south portal of the Battery Street Tunnel. The northbound outside lane would split off from the through lanes between Virginia and Lenora Streets and rise up to Western Avenue as an exit ramp.

Similarly, the southbound lanes would exit the Battery Street Tunnel at a 7 percent downhill grade and immediately pass below Western and Elliott Avenues. South of Elliott Avenue, the Elliott on-ramp would be an aerial structure that would join the southbound lanes (also on an aerial structure) past Lenora Street. These three lanes would continue on the aerial structure over the BNSF Railway tracks. An emergency fire access and maintenance lane would be provided behind the Waterfront Landings condominiums.

The Elliott Avenue on-ramp and Western Avenue off-ramp would be rebuilt.

1.2.3 Elevated Structure Alternative

The alignment for the Elevated Structure Alternative in the south area would be generally very similar to that of the Cut-and-Cover Tunnel Alternative. Beginning near S. Royal Brougham Way, SR 99 would be an at-grade roadway with ramps at S. Royal Brougham Way and S. Dearborn Street.

In the central section of downtown Seattle, the Elevated Structure Alternative would replace the existing Alaskan Way Viaduct with a stacked aerial structure along the central waterfront. The SR 99 roadway would convey three lanes of traffic in each direction, with wider lanes and shoulders than the existing viaduct.

The existing ramps at Columbia and Seneca Streets would be rebuilt.

SR 99 would travel over Elliott and Western Avenues and connect to the Battery Street Tunnel on an aerial structure that would be reduced to two lanes as it enters the Battery Street Tunnel by dropping a northbound lane to Western Avenue. The Elliott and Western Avenue ramps would be rebuilt, and the existing southbound off-ramp to Battery Street and the northbound on-ramp from Western Avenue would be maintained for emergency and maintenance use only.

The Elevated Structure Alternative would replace the Elliott Bay Seawall between S. Jackson and Broad Streets in the central waterfront section. Between S. King Street and Yesler Way, the soils would be strengthened and a new bulkhead would replace the currently failing bulkhead. New face panels would be installed wherever feasible. From Madison Street to Union Street, the new seawall would be close to or slightly behind (landward of) the existing seawall. North of Union Street, soils strengthening would be needed to construct the new seawall structure, except for a section near Pier 66 that was replaced in the 1990s.

1.3 Summary

This discipline report consists of 8 chapters and 10 attachments. Chapter 1 summarizes the historical background related to the overarching environmental review process of which this report is a part and summarizes the objectives, studies, findings, conclusions, and recommendations included in the report. Chapter 2 summarizes the methodology used to research, screen, and assess the potential for hazardous materials to affect the project. Chapter 3 details the evaluations that were conducted. Chapter 4 discusses the physical setting of the project and describes historical land uses from south to north. A summary of environmental sampling results within the study areas is provided and the potential implications of these results are discussed. Sites that may pose an environmental risk to the project due to documented contamination or historical land use are listed and discussed. Chapter 5 discusses hazardous materials impacts that may occur during the operation of the facility, and Chapter 6 discusses hazardous materials impacts that may occur during construction. Chapter 7 provides a brief discussion of tolling as it relates to potential hazardous materials in the project area. Chapter 8 provides a list of references that have been used in preparing this report.

Attachments A through G present the studies and/or the findings of evaluations that are discussed in Chapter 3. Attachment H presents the properties that would be acquired and indicates the investigations recommended for each property for each of the build alternatives. Attachment I presents the applicable laws and regulations, and Attachment J describes standard mitigation measures that could be used.

1.3.1 Hazardous Materials Evaluation Overview

This discipline report presents the results of an evaluation performed to identify properties that have the potential to contain hazardous materials, the presence of which could affect the replacement of the existing Alaskan Way Viaduct. No sites would pose a significant unavoidable adverse impact that could not be mitigated.

This report discusses design and construction issues as they relate to hazardous materials and their associated effects and mitigation. It also includes a discussion of these issues and effects in comparison with existing conditions and with conditions under the Viaduct Closed (No Build Alternative).

Conditions were evaluated in two study areas, which using the greatest extent of the project limits include the alignment of SR 99 from S. Atlantic Street to Aloha Street and the area within approximately 400 feet (two city blocks) of the alignment. One study area encompasses the alignments for the Cut-and-Cover Tunnel Alternative and the Elevated Structure Alternative because of their similar area and project elements. The other study area encompasses the alignment for the Bored Tunnel Alternative. The two study areas overlap in the south, in the southern portion of the central area located near the waterfront, and in the area north of Denny Way.

In the descriptions of the affected area and the discussions of potential operational and construction effects, the study areas are divided into the south area, the central area, and the north area.

1.3.2 Regulatory Considerations

Numerous federal, state, and local regulations and policies govern decisions concerning the potential and liability for hazardous materials and hazardous waste. Federal and state regulations that apply to the project are listed in Attachment I. Applicable local regulations are discussed in Section 6.5.

1.3.3 Methodology

The historical and regulatory research that was conducted to identify known or potentially contaminated properties is similar to the ASTM International (ASTM) standard for conducting a Phase I environmental site assessment (ESA). Information on current and historical land uses and records of environmental enforcement were reviewed to identify potentially contaminated properties and properties with documented releases within the study areas. Properties within the study areas that were deemed sufficiently close as to have a potential adverse effect on the environment and the project were considered “sites of concern.” Based on the proximity of these sites of concern to the project area, the type and level of contaminants that are or could be present, the anticipated construction activity, and the status of the property acquisition, sites that could adversely affect the project were retained as “validated sites.” The validated sites were then categorized as high, moderate, or low potential impact, as defined by the Washington State Department of Transportation (WSDOT) (WSDOT 2009). The screening criteria used to identify validated sites are summarized in Section 2.3.

1.3.4 Affected Environment

The study areas are characterized by industrial, commercial, and residential activity. The south area is primarily industrial in nature, including past and current railroad operations. Container short-term storage and transfer operations have replaced other industrial activities on Port of Seattle property adjacent to the SR 99 alignment. Former industries in the south area include metal works, foundries and plating operations, machine shops, warehouses, and fueling facilities, as discussed in Section 4.3, Historical Land Use. The most likely contaminants from such historical operations include metals, solvents, and petroleum products. The area is underlain by fill that was placed in the early 1900s, covering and incorporating timber and debris that previously had been used in the construction of piers, wharves, and trestles. Common contaminants in this old fill include petroleum constituents and metals. In addition, some of the buried piles and timbers had probably been treated with creosote, which likely has leached into the adjoining soil and groundwater. Cinders (possibly from the Great Seattle Fire of 1889) and coal have been identified, and lubricating oil associated with railroad operations may be encountered in the fill soils.

The central area along the waterfront historically had industrial use similar to that of the south area. Railroads and a trestle-supported road were originally located west of the shore. The area was filled and supported commercial activity, as wells as Port of Seattle uses along the waterfront. The commercial district in the central part of the city historically included dry cleaners, printers, lithographers, auto repair shops, gas stations, and commercial residential properties such as hotels and apartments. In the last 20 years, condominiums have been constructed near the Battery Street Tunnel and the north end of the bored tunnel section, mostly displacing commercial use.

The north area is a commercial area; primary businesses in this area are dry cleaners, auto repair shops, gas stations, and motels. The most likely contaminants at both the south and north portals of the bored tunnel alignment are petroleum products, lead that may be present in gasoline, other heavy metals, and solvents. Solvents typically associated with printers and dry cleaners are the contaminants most likely to have migrated to the depth of the tunnels.

Historical land uses potentially resulted in releases of a variety of hazardous materials into the surrounding environment, resulting in soil and groundwater contamination that could adversely affect the project.

Because there has been only limited redevelopment in the central part of the project area, most of the buildings were constructed before the enactment of recent laws restricting the use of hazardous building materials. The buildings were constructed as early as 1910. Therefore, the presence of asbestos-containing materials (ACM) and lead-based paint (LBP) should be expected in many of the buildings in the area. ACM, LBP, and lead-containing soot have been identified in the existing Battery Street Tunnel, which would be decommissioned as part of the Bored Tunnel Alternative.

1.3.5 Operational Effects, Mitigation, and Benefits

The Viaduct Closed (No Build Alternative) includes two scenarios: (1) sudden closure of SR 99 due to an event that renders the structure unsafe, and (2) collapse of the viaduct during an earthquake.

The operational effects of the three build alternatives are primarily related to stormwater quality. No operational effects were identified that could not be mitigated through proper design, construction, and management. Compared with conditions under the Viaduct Closed (No Build Alternative), the build alternatives would reduce pollutant loading and improve the quality of stormwater runoff discharged from the study area to surface water.

Under all three of the build alternatives, improvements to surface streets would include stormwater flow control and water-quality treatment measures in compliance with Seattle's drainage code, and the City of Seattle Department of Planning and Development (DPD) and Seattle Public Utilities (SPU) Director's Rules for stormwater, grading, and drainage control. Stormwater quality would be maintained or potentially improved compared to existing conditions. Seepage in the bored tunnel or the cut-and-cover tunnel would be discharged to the combined sewer system and would need to comply with the DPD and SPU Director's Rules related to discharges to the side sewer.

Because of the coarse backfill that surrounds utilities, the utility corridors in the study areas could act as preferential pathways for contaminant migration. To prevent the development of preferential migration pathways for contaminants in shallow groundwater, controlled-density fill (CDF) or trench dams could be installed at intervals along utility runs.

As with any roadway, spills of hazardous materials could occur. The fire department is equipped to respond to spills and fires. Appropriate institutional measures would be necessary for ongoing control of accidentally released contaminants to avoid the creation of preferential pathways.

Under both the Bored Tunnel Alternative and the Cut-and-Cover Tunnel Alternative, a large quantity of subsurface contaminants would be removed. Under the Cut-and-Cover Tunnel Alternative, more contaminants would be removed because the entire length of the tunnel would be located in fill soils along the waterfront. The subsurface conditions would be improved, and potential contaminant sources that could otherwise affect groundwater quality would be removed. Improved subsurface conditions would decrease the potential exposure of utility workers to hazardous materials in the future.

If groundwater mounding occurs upgradient of the cut-and-cover tunnels, bored tunnel, retaining walls, and areas of ground improvement, the water level on the east and west sides of the affected areas could be equalized by the installation of pipes and drainage trenches. The mounding is expected to be within the normal range of fluctuations. The placement of the pipes and trenches could be adjusted if groundwater contaminants are encountered so as not to make the existing conditions worse.

Air in subsurface structures could be affected by soil vapor from nearby contaminated soil and groundwater. Vapor barriers could be installed to prevent the intrusion of vapors, particularly those associated with gasoline and dry-cleaning solvents, into basements or vaults. Vapor intrusion has not been identified along the alignment.

1.3.6 Construction Effects and Mitigation

All of the build alternatives have been designed to avoid contamination where possible. Where contamination cannot be avoided, planning and design, as well as construction techniques and practices, would be implemented with the intent of minimizing the release of contaminated media to the environment. Construction effects from contaminated media would be mitigated by developing and implementing construction plans that describe the management of contaminated media. Construction effects would also be mitigated by establishing a budget that reflects the costs associated with disposing of contaminated spoils and dewatering water. Although it may increase up-front costs, early identification of contaminated soil and groundwater and characterization of waste may minimize the volume of contaminated spoils. Contaminated spoils could be segregated for appropriate disposal. Adequate laydown areas have been identified to allow soil stockpiling, without adversely affecting the construction schedule.

Construction effects could result if contaminated soil or groundwater is encountered during various construction activities (e.g., drilling of shafts, deep soil mixing (DSM), jet grouting, compensation grouting, excavation for retaining walls and cut-and-cover tunnels, tunnel boring, and relocation of utilities). In addition to the sites that have been identified as potentially contaminated, the SR 99 alignment is underlain by fill that consists of soil and debris from unknown sources. Construction throughout the project area could encounter contaminants such as petroleum, metals, and polycyclic aromatic hydrocarbons (PAHs) in the fill soils, as well as creosote-treated timbers and wood debris. Solvent- and petroleum-contaminated soil is present in the north area between Denny Way and Mercer Street.

To reduce potential schedule delays, costs, and liability for contaminated soil and water on the project, special handling and disposal would be required. Other measures would include provisions for the health and safety of workers and the public and the protection of the environment from releases of contaminants, the spread of contamination, and cross-contamination.

Although construction in the north and south areas would be similar for all of the build alternatives and would involve many similar methods, there are some distinctions between the hazardous materials impacts that could result from their construction. The greatest number of parcels and buildings would be acquired for the Cut-and-Cover Tunnel Alternative (40 parcels and 12 buildings). The Elevated Structure Alternative would acquire or modify slightly fewer parcels

(37 parcels and 12 buildings). The Bored Tunnel Alternative would require the acquisition of seven parcels and four buildings. Because of the similar alignments for the Elevated Structure Alternative and the Cut-and-Cover Tunnel Alternative, the same 244 validated sites could potentially affect each of these alternatives. For the Bored Tunnel Alternative, 102 validated sites were identified. A few large parcels encompass more than one validated site, and some large parcels encompass no validated sites, or the portion of the parcel that is being acquired has not been identified as a validated site. A majority of the validated sites are associated with former railroad operations, metal works, a junkyard, gas stations, and dry-cleaning operations. Permanent and temporary construction easements and temporary tieback easements would also be acquired for each of the alternatives. Building and parcel acquisitions and easements are discussed in the *SR 99 Bored Tunnel Right-of-Way Needs and Boundaries Summary Report* (PB 2009a).

Under the Cut-and-Cover Tunnel Alternative and the Elevated Structure Alternative, five of the validated sites (seven parcels) would pose a high potential impact on the project because of potential solvent contamination. Only three of these sites are associated with the Bored Tunnel Alternative, and two of them are owned by the City.

The site investigations that have been conducted well before construction reduce the risk of adverse effects from these sites. Understanding the distribution and concentration of contaminants allows more effective management of spoils and contributes to more accurate estimates of costs and time for handling and disposing of contaminated media. Treatment or removal of some areas of contaminated soils could occur in advance of construction. Additionally, the construction approach and techniques can be modified to address potentially contaminated media.

As part of the property transfer proceedings, Phase II ESAs and other environmental sampling activities are sometimes conducted to identify potential contaminants that could be encountered during construction. Explorations conducted for the engineering design could provide sufficient data on hazardous materials sites in other portions of the project area.

In September 2010, WSDOT conducted an environmental investigation to reduce potential impacts associated with a former dry-cleaning operation on Site 60.3-1, (the Vagabond Inn, currently the Seattle Pacific Hotel), which has documented soil and groundwater contamination. Explorations were performed near the proposed location of the tunnel operations building at the north portal associated with the Bored Tunnel Alternative, which would be on the adjacent parcel west of Site 60.3-1. For the building construction, soil would be excavated to a maximum depth of 80 feet bgs, and perched water zones would be dewatered. During the explorations in 2010, the area, depth, and concentrations of solvent-contaminated soil and groundwater were identified. The western extent of contamination was assessed to determine whether the soil to be excavated for the building is contaminated. Based on results of the explorations, soil that would be excavated for the north tunnel operations building would qualify for a "contained-out" designation. The Washington State Department of Ecology (Ecology) would need to issue that designation for soil to be disposed of at a Resource Conservation and Recovery Act (RCRA) Subtitle D landfill. Without Ecology's designation, the excavated soil would have to be disposed of as "dangerous" waste at a RCRA Subtitle C landfill, at a significantly higher cost. A preconstruction determination of contained-out soil would also expedite the handling and disposal efforts, reducing potential schedule delays. Construction of the north tunnel operations building could then proceed with a site-specific management approach for spoils and groundwater that would reduce potential risk to the project.

Properties adjacent to the alignment that may have underground storage tanks (USTs) have also been identified. Historically, tanks that were no longer needed were abandoned rather than removed, and residual fuel was left in the tanks. Over time, these tanks may have released the fuel, resulting in contaminated soil and groundwater. Abandoned USTs represent multiple localized potential sources of contamination along the alignments of the build alternatives. These abandoned tanks could still contain petroleum products. Identified USTs include tanks registered with Ecology, USTs at former gas stations, and domestic tanks that formerly stored oil for heating buildings. Geophysical investigation methods, including ground-penetrating radar, electromagnetic methods, metal detection, or magnetometry surveys, are recommended for properties that would be acquired and may still have USTs.

Construction activities on UST sites and other sites with hazardous materials could result in the following types of effects related to hazardous materials:

- Large volumes of spoils containing contaminated soil and debris could be generated.
- Grout and muck waste could cause an elevated pH in spoils and groundwater.
- Contaminated groundwater could be encountered and drawn into areas that were previously uncontaminated, and discharge from dewatering operations could contain hazardous materials.
- Groundwater pathways could be modified by subsurface construction or dewatering, resulting in the mobilization and spread of existing contaminants.
- Air quality could be affected by releases of contaminants and dust during construction and handling of contaminated media.

Construction activities that would involve direct soil removal include excavation for tunnels, foundations, retaining walls, utility installation and relocation, and soil improvement. Similarly, the use of drilled shafts for the construction of foundations and diaphragm walls would generate spoils that would require handling and proper disposal. A contaminated soil management plan (CSMP) that addresses handling, storage, and disposal of contaminated materials, including pH-affected spoils, would reduce potential schedule delays associated with contaminated spoils.

Other construction management plans would include measures that could be implemented to protect stormwater and surface water, as described in Appendix O, Surface Water Discipline Report. Handling and disposal options are also discussed in the *Draft Spoils Handling and Disposal Planning Report* (PB 2009b) and the *CT-15 Environmental Considerations Report* (Shannon & Wilson 2010a). The ground improvement techniques that would be used would also generate large volumes of spoils. Jet grouting operations, which consist of the injection of cement grout to strengthen the subsurface soils, typically produce spoil volumes equal to about 50 to 70 percent of the volume of soil treated. An estimated 20 percent of these spoils would be solids. This spoil material would consist of a blend of eroded soil and cement grout that is flushed to the ground surface during grouting.

DSM, which involves in situ mechanical mixing of soil and cement, would produce spoil volumes equal to about 30 to 50 percent of the DSM column area (the columns typically constitute about 30 percent of the total treated area). The spoils from DSM would consist of blended soil and cement with the consistency of a thick mud; this material would have to be allowed to settle before it could be handled or disposed of. Soil improvement methods that use cement result in spoils with a high pH because of the comingled cement and soil. Spoils with a high pH require special handling and disposal. These spoils are considered a “problem” waste because of the disposal restrictions imposed on them.

Along the bored tunnel section of the Bored Tunnel Alternative, compensation grouting may be performed to stabilize soil and mitigate ground loss during tunneling. Grouting may be performed through the tunnel liner, beneath structures where settlement is expected (e.g., buildings). The pH of the spoils generated during the advancement of the grout hole may be affected because of the spoils would be comingled with cement.

Ground improvement for the Bored Tunnel Alternative would likely be performed between S. Dearborn Street and S. Jackson Street and near Yesler Way, where the tunnel passes under the existing viaduct. Where ground improvement is necessary, care would be taken not to adversely affect existing underground utilities. Under the Cut-and-Cover Tunnel Alternative, the cut-and-cover tunnel would replace the seawall; therefore, only the south area and north of Union Street to Broad Street would require ground improvement. Ground improvement for the Elevated Structure Alternative would occur along the southern and central portions of the alignment near the waterfront and continue north to Broad Street as part of the seawall replacement.

In the south area, the fill soils consist of soil comingled with substantial quantities of wood debris and sawdust, in addition to other debris such as coal. The distribution and quantity of the wood debris prevent the excavated fill soils from being reused as fill unless the wood debris is removed. Because of the methane that is generated when the woody debris decomposes, land reclamation facilities typically accept spoils with less than 5 percent organic matter. The wood timbers and piles would require segregation to improve handling and transport conditions for disposal at a facility or landfill. The fill soils are also contaminated with low concentrations of petroleum, metals, volatile organic compounds (VOCs), and PAHs (associated with oil and coal). Contaminant concentrations in soils may not always be greater than the cleanup levels established by the Model Toxics Control Act (MTCA). However, they would likely require disposal at either a land reclamation facility permitted to accept low-level contaminated soil with a pH of less than 8.5 or a RCRA Subtitle D landfill that has no restrictions on the levels and types of contaminants, as long as the spoils are not considered dangerous waste. If there is sufficient space to stockpile soil, the contractor may segregate excavated soil with low levels of contamination from soil with contaminant levels exceeding the MTCA Method A cleanup levels. Based on engineering estimates prepared for the Bored Tunnel Alternative, laydown areas should have a capacity to stockpile 25,000 cubic yards (cy), approximately 2 weeks' worth of excavation spoils. Adequate space for stockpiling is necessary so that the excavation schedule is not affected. A similar laydown area would be required for the Cut-and-Cover Tunnel Alternative. A smaller laydown area would be required for the Elevated Structure Alternative because the volume of spoils would be substantially less than that for the other alternatives.

Under the Elevated Structure Alternative and the Cut-and-Cover Tunnel Alternative, conditions in the central area are similar to those in the south area. The cut-and-cover tunnel would be approximately 80 feet deep and would encounter fill in the upper part of the tunnel. The fill thickness in the southern part of the alignment is typically 20 to 30 feet and the thickness increases to the north. The fill on the west side of the alignments for these alternatives ranges from 15 to 50 feet thick and is roughly 10 to 20 feet thicker than the fill deposits on the east side. Although excavation along the waterfront would not be necessary for the elevated structure, large volumes of spoils would be generated during the ground improvement and the installation of large-diameter drilled shafts. These spoils would have a high pH because of the cement, and the spoils generated from the fill zone likely would be contaminated as well, as described in the discussion of the south area.

Under the Bored Tunnel Alternative, the bored tunnel would be advanced through primarily native soil. Although the spoils would likely require special handling because of an elevated pH level, widespread contamination has not been identified in native soil in the central area. Elevated concentrations of metals may be encountered, generally less than the MTCA Method A cleanup levels, with possible isolated occurrences of organic contaminants. Glacially deposited soil may have elevated levels of pH (above 8.5). In addition, additives mixed with soil may increase the pH of the spoils.

In the north area, petroleum contamination is expected because of the numerous former gas stations in that area. Spent solvents from former dry-cleaning operations may also be present in soil that would be excavated. Soils containing the spent solvent tetrachloroethylene, commonly associated with dry cleaning, are typically considered a dangerous waste according to Washington Administrative Code, Chapter 173-303 (WAC 173-303). As such, they require disposal at a RCRA Subtitle C disposal facility, unless disposal has been otherwise coordinated with Ecology. The Cut-and-Cover Tunnel and Elevated Structure Alternatives would acquire properties where dry-cleaning businesses operated. One of the properties has a documented solvent release (Site 60.3-1, Vagabond Inn site, currently Seattle Pacific Hotel). The property adjacent to Site 60.3-1 on the south would also be acquired for these alternatives. For the Bored Tunnel Alternative, the properties south and west of Site 60.3-1 would be acquired, but only temporary tiebacks would be installed at the site. Investigations conducted by the property owner indicate that the highest concentrations of solvents are present in the middle of Site 60.3-1. Additional investigations would likely be necessary before soil on the property could be excavated.

In 2010, WSDOT evaluated the contaminant distribution on the adjacent parcels south and west of the Site 60.3-1. Soil and groundwater would be removed from these areas as part of the Bored Tunnel Alternative. The soil would qualify for a contained-out designation from Ecology and could be disposed of at a RCRA Subtitle D Landfill.

The greatest quantity of spoils that would be generated would be associated with the Cut-and-Cover Tunnel Alternative (estimated 2,007,000 cy). Of this volume, an estimated 1,437,000 cy could be contaminated or require special handling. Most of the spoils would be removed from the central area, in an area of fill and wood debris (including creosote-treated pilings that supported former elevated railroads and a wood-plank road). The volume of material removed for the Elevated Structure Alternative would be 806,000 cy, with 82 percent (660,920 cy) of the spoils contaminated or requiring special handling, primarily because they would be comingled with cement.

The Bored Tunnel Alternative would generate an estimated 1,573,500 cy of spoils from excavations, ground improvement, and tunnel boring. Approximately 92 percent (1,451,000 cy) could require special handling and disposal because of contamination or an elevated pH (problem waste). Included in this estimate is soil or spoils that contain compounds or elements that restrict where the waste can be reused or disposed of, waste with pH values greater than 8.5, and waste containing high concentrations of organic matter, such as woody debris, sawdust, or timbers. Fill soil to be excavated from the south area contains wood debris (including creosote-treated pilings). Spoils that would require special handling include 949,000 cy of spoils from the bored tunnel. These spoils are less likely to contain contaminants, but they may have elevated pH levels, either naturally occurring or introduced by the additives. These spoils may be treated to reduce the pH.

The maximum daily volume of soil that could be excavated in the portal areas of the bored tunnel is estimated to be approximately 2,800 cy. This is the equivalent of approximately 4,000 to 5,000 tons of soil, assuming a multiplier of 1.8 cy per ton. The volume of spoils from the bored tunnel would likely range between 3,900 and 6,600 tons per day, assuming that the tunnel boring machine (TBM) advances 30 to 50 feet per day. Waste handlers for problem waste estimate that they can accept approximately 5,000 tons of soil per day for disposal at a RCRA Subtitle D landfill that has no restrictions on levels of contamination, organic content, and pH level, as long as it is not considered dangerous waste. Although the estimates indicate substantial volumes of spoils that would require disposal, coordination and budgeting for disposal in advance would help to mitigate the spoils disposal issue. For temporary storage, soil could be stockpiled at proposed staging areas in the south end of the project area. In addition, more than one waste disposal company may be used to address the volume of soil requiring disposal.

The volume of spoils waste, particularly from DSM and jet grouting, could be reduced in some areas by using alternative technologies that would generate less spoils. The use of vibro-replacement (stone columns), is not the most likely method of ground improvement given the particular conditions; however, it could still be considered. The installation of stone columns could possibly result in the displacement of perched groundwater. It could also potentially affect building foundations in the area, depending on soil conditions. Drilled shafts, installed as a foundation element, may require casing in areas where caving and sloughing are likely. This would reduce both the volume of soil generated and the potential for contamination of the slurry used to complete the shafts.

Dewatering activities would also be required for the cut-and-cover tunnels, retained cuts, and deep excavations for the tunnel operations buildings. Water from dewatering would be discharged to the sewer system or it would be reinjected to mitigate the potential effects of dewatering, including settlement of structures and changes in groundwater flow. No dewatering water would be discharged directly to Elliott Bay. Water that is discharged to the combined sewer could require treatment before discharge to comply with the conditions of the King County Wastewater Discharge Permit or Authorization. Water that does not comply would be disposed of offsite. Off-site disposal may also be necessary if the volume of water exceeds the project's volumetric permit discharge limits or if King County specifically requests discharges to cease. Dewatering water that is directly reinjected would not be allowed to degrade groundwater quality.

The water table in the south area is about 2 to 12 feet bgs, increasing to 8 to 12 feet bgs north along the waterfront because of the increase in ground surface elevation. Groundwater flow could be altered by the presence of the walls supporting the retained cuts, cut-and-cover tunnel, and ground improvement areas. The walls would essentially block the flow of groundwater and could cause groundwater to mound up against the wall. Groundwater mounding may occur along the east side of the walls because groundwater flow is generally toward Elliott Bay. Pipes and drainage trenches could be installed to reduce the effect of groundwater mounding and minimize changes in groundwater gradients, if necessary. Groundwater mounding is expected to be within the normal range of groundwater level fluctuation.

To the extent feasible, the dewatering systems required for construction would be designed to minimize drawdown of the water table. This would reduce the volume of groundwater requiring treatment and disposal. It would also reduce the potential for the mobilization and spread of groundwater contaminants in the project area. The retained cuts and cut-and-cover sections of the roadway and ramps, and deep excavations for structures would likely be supported by diaphragm walls. A diaphragm wall is constructed using drilled shafts (secant or tangent) and/or slurry wall or DSM techniques to form a continuous reinforced-concrete wall that provides lateral support and serves as an impermeable barrier. Under the Bored Tunnel Alternative, the south area would also include a tunnel operations building, located in the block bounded by S. Dearborn Street, Alaskan Way S., and Railroad Way S. Portions of this building would extend underground to match the tunnel grade in this area (up to about 75 bgs). A diaphragm wall would also be the likely method used for the cut-and-cover tunnel along the waterfront, which is anticipated to be up to 86 feet bgs. These walls would create a barrier to groundwater flow. Shallow groundwater from within the excavation could be discharged to the sewer. Large-scale dewatering from the deeper water-bearing zone would be performed to keep the water level below the bottom of the excavation. In addition to mitigating the potential settlement of structures, the reinjected groundwater would act as a hydraulic barrier and reduce drawdown effects and potential changes in groundwater pathways.

Potential effects on air quality due to contaminants, dust, and nuisance odors could be mitigated, where required, by avoidance measures, best management practices, or engineering controls. Depending on the size of the excavation, work areas could be covered to reduce the effect of dust and odors, or the amount of active work surface that is open could be reduced. Engineering controls could also be implemented, such as wetting of surfaces with water or polyacrylamide blends that bind soil to prevent it from becoming airborne, ventilation with fans, and air filtration methods. Work associated with the project would be planned to control fugitive dust during construction according to an existing agreement between WSDOT and the Puget Sound Clean Air Agency (PSCAA). Air quality is addressed in Appendix M, Air Discipline Report.

Under all three build alternatives, the existing viaduct would be demolished, resulting in debris. Debris would also be associated with improving the Battery Street Tunnel under the Cut-and-Cover Tunnel and Elevated Structure Alternatives, or decommissioning it under the Bored Tunnel Alternative. Under the Bored Tunnel Alternative, construction debris including concrete from the existing viaduct could be used to fill the Battery Street Tunnel. Appropriate management and handling of demolition material from the viaduct would be implemented to address the specific environmental hazards associated with concrete rubble, including high pH. In addition, necessary regulatory permits and approvals would be procured if they were determined to be necessary to perform this type of construction activity.

ACM and LBP are likely present in the buildings that would be acquired for the project. Buildings constructed as early as 1910 could be acquired. ACM and LBP have been identified at various locations in the Battery Street Tunnel. Soot within the tunnel contains high concentrations of metals (greater than the dangerous waste threshold) and other contaminants. Before demolishing any building or structure, hazardous materials building surveys would be conducted to identify the presence of hazardous materials and determine quantities for removal.

Chapter 2 METHODOLOGY

The objective of this discipline report is to identify current and historical land uses near the project area that have the potential to result in environmental contamination and to assess the possible environmental effects of such hazardous material sites on the project. This chapter describes the research, screening, and risk criteria that was used to identify sites with the potential to affect the project.

The historical and regulatory records research for this report was similar to the ASTM 1527 standard for conducting a Phase I ESA. The investigation includes (1) researching current and historical land use within the study area, (2) reviewing U.S. Environmental Protection Agency (EPA) and Ecology databases to identify businesses that use hazardous materials and properties where a hazardous material release is confirmed or suspected (ASTM 1527 search distances), and (3) reviewing Ecology files for businesses with documented contamination. Environmental conditions that may affect the distribution of contaminants and the potential for contaminants to affect project construction were also evaluated.

2.1 Records Reviews and Project Research

Research was conducted to identify potential sites of concern and to gain an understanding of surface and subsurface conditions that could affect the project. The research consisted of the following:

- Review of historical records related to the study areas
- Review of regulatory records
- Review of Ecology files for known and suspected contaminated sites
- Review of current King County tax assessor records for properties located adjacent to the alignments for the build alternatives
- Windshield survey of the north and south portal areas for the Bored Tunnel Alternative
- Interviews with the Seattle fire marshal and King County Health Department
- Evaluation of potential to encounter asbestos and LBP during building demolition
- Review of reports of ESAs and hazardous material surveys for properties within the study areas
- Review of area geology as it applies to contaminant distribution and migration, based on Appendix P, Earth Discipline Report

A description of each of these elements of the research is provided in Chapter 3, Studies and Coordination.

2.2 Study Areas

The evaluations associated with this discipline report were performed for two overlapping study areas. One study area extends along alignment for the Bored Tunnel Alternative. The other study area extends along the alignments for the Cut-and-Cover Tunnel Alternative and the Elevated Structure Alternative.

For the purpose of this discussion, the study area for the Bored Tunnel Alternative has been divided into the three areas:

- South – S. Atlantic Street to S. King Street
- Bored Tunnel – S. King Street to Thomas Street
- North – Thomas Street to Roy Street

The study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives has been divided into the following areas, with portions of this study area overlapping the study area for the Bored Tunnel Alternative:

- South – S. Royal Brougham Way to S. Dearborn Street
- Central – S. Dearborn Street through Battery Street Tunnel (Denny Way), including the seawall and waterfront from S. Washington Street to Broad Street
- North – Denny Way to Aloha Street

Each study area includes the area extending approximately 400 feet (two blocks) from the alignment for the alternative, including blocks adjacent to on- and off-ramps or surface streets that would be modified as part of the alternative, and any parcels that may be used as temporary laydown areas. The distance of 400 feet on either side of the alignment was selected because it was judged to encompass the areas from which contamination could reasonably be expected to migrate to the project footprint based on the topography, soils, and groundwater in the project area. Contamination on sites identified within the study area has the potential to migrate outside the project footprint.

A number of factors were considered in selecting two blocks on either side of the alignment as the study area boundary. Subsurface conditions in the north and central upland areas are characterized by dense soils and the presence of discontinuous perched water zones to a depth of at least 75 feet bgs. These factors reduce the potential for migration of contaminants in these areas.

Although subsurface conditions in the south and central waterfront areas are characterized by a shallow aquifer and soils that are more permeable, fill up to 50 feet thick is present. Generally, low levels of contaminants have been encountered in the fill soils. Furthermore, industrial and commercial businesses have operated in this part of the city since the early 1900s. It would be difficult to attribute contaminants to businesses more than 400 feet from the alignment, given the likely presence of contaminated fill, and the density of similar businesses that were located over or adjacent to the alignment.

2.3 Site Screening and Evaluation Criteria

Historical and regulatory records were reviewed to identify potential sites of concern in the study areas based on the property's land use and regulatory database listing (these studies are discussed in more detail in Chapter 3).

From the review of historical records (e.g., archived tax records, current tax records, aerial photographs, Sanborn fire insurance maps, and Polk directories), independent lists of businesses that may have used hazardous materials were compiled. The lists were cross-referenced to determine the type of business, its location and property boundaries, and its duration of operation.

Each business operation was assigned a site identifier number. The site identifier number consists of a block designation followed by the site number. Blocks were numbered from north to south and were based on the original city plat maps. Blocks located south of King Street are substantially larger because parcels have been combined for the Port of Seattle terminals and railyards. An example is Site 50.3-1, where 50.3 is the block number, and 1 identifies the parcel(s) associated with the land use (business operation) that likely used hazardous materials.

Businesses occupying the same parcel were collectively assigned one site number. If the business type and parcel boundaries were different, a separate site number was assigned that overlapped the other site boundaries.

Sites identified in the historical records were then compared with sites identified in the regulatory records. If the parcel boundaries were the same, the sites were combined and identified as a single unique site. Sites identified in the regulatory records were often new sites because the parcel boundaries were different. In many instances, although there was no historical land use of concern associated with a site listed in the regulatory records, a release was documented. The most common release involved oil that had been used to heat the structure. The process used for the initial screening of the historical records and regulatory records for potential properties of concern is described in more detail in Sections 2.3.1 and 2.3.2. The process used to identify risk to the environment and rank the potential impact of each site on the project is described in Section 2.3.3.

2.3.1 Initial Regulatory Sites Screening

Sites with documented releases are defined as those that are identified in the regulatory (EPA and Ecology) databases as having reported a release of contaminants into the soil, sediment, or groundwater of a property. Other sites identified during the regulatory database search include generators of hazardous wastes (not necessarily indicating a release) and registered USTs. Sites upgradient and within ½ mile of the alignments were evaluated for off-site contamination that could have migrated to the project area. A review of Ecology records indicated that no sites outside the study area are likely to affect the project, and these sites were eliminated from further evaluation.

The evaluation included sites within the study areas that are listed in the regulatory records. Elimination from the evaluation was based on the following screening criteria:

- Sites listed solely in the Resource Conservation and Recovery Act Information (RCRAInfo) database. Inclusion on the RCRAInfo list indicates that a site uses or generates regulated materials as part of its business function, but it gives no indication of releases to soil or groundwater.
- Sites listed solely in the Emergency Response Notification System (ERNS) database. Inclusion on the ERNS list indicates that a spill has occurred on the site. The sites are not included on other lists; there is no indication of soil or groundwater contamination.
- Sites included solely on the state UST list (not included on the state leaking underground storage tank (LUST), Voluntary Cleanup Program (VCP), Confirmed and Suspected Contaminated Sites List (CSCSL), and Washington Site Register of Independent Cleanup Reports (ICR) lists as potential release sites). USTs were evaluated separately.
- Sites located downgradient of the alternatives alignment. A review of the Ecology file did not indicate potential off-site migration of contaminants.
- Sites located upgradient or crossgradient of the alternatives alignment that were excluded for a variety of reasons, including distance from the project area, distance to the tunnel crown for the Bored Tunnel Alternative, type of contaminant, apparent completion of remediation, and expected excavation depth.

Excluded sites and the rationale for their exclusion are indicated in Attachment B.

2.3.2 Initial Historical Sites Screening

A list of the historical businesses and industries within the study areas that are likely to have been associated with the generation, storage, or transportation of hazardous materials was developed based on the review of historical records (Exhibit 2-1). Although a variety of contaminants may have been used at some sites, only the contaminants most likely to be encountered at each business type are identified.

Exhibit 2-1. Types of Businesses and Typical Related Contaminants

Business	Likely Contaminants	Typical Analytes
Auto service	***Petroleum***, solvents	Kerosene, turpentine, methylene chloride, BTEX, TCE, PCE, Stoddard solvent, hydrofluoric acid, asbestos
Auto washing	***Petroleum,*** PAHs	
Auto wrecking/junkyard	***Petroleum***, metals	Gasoline, lead, antifreeze, oils, battery acid
Batteries	***Metals***, other	Lead, battery acid
Blacksmiths	***Metals,*** PAHs	
City Light (power) substation	***PCBs,*** oils	
Cleaners/laundry	***Solvents,*** phosphates	Carbon tetrachloride, TCE, PCE, *cis*-1,2-DCE, vinyl chloride, Stoddard solvent
Coal storage/bunker	***Petroleum, PAHs***, metals	Arsenic, mercury, cadmium, boron
Dyer	***Solvents***	
Foundry	***Metals,*** solvents	Chromium, cadmium, lead, copper, nickel, zinc, iron, phenols, toluene
Gas station	***Petroleum***	BTEX
Gas station with auto service	***Petroleum***, solvents	BTEX, TCE, PCE
Hat cleaner	***Solvents***	TCE, PCE, *cis*-1,2-DCE, vinyl chloride
Laundry/laundromat only	***Solvents***	TCE, PCE, *cis*-1,2-DCE, vinyl chloride
Lithographer	***Solvents***, metals	Methanol, toluene, TCE, methylene chloride, petroleum, naphtha, IPA, copper, zinc, barium, lead (before 1970), arsenic, selenium, mercury, cadmium, hexavalent chromium
Machinists	***Metals,*** solvents, petroleum	Oil, PCE, TCE, *cis*-1,2-DCE, vinyl chloride
Manufacturing chemists	***Solvents,*** petroleum	
Metal plating	***Metals,*** solvents	Mercury, BTEX, TCE, PCE
Oil burner repair/sales	***Petroleum***	
Painter	***Solvents***, metals	BTEX, TCE, PCE, *cis*-1,2-DCE, vinyl chloride, turpentine, mineral spirits
Photo finisher	***Solvents***, metals	Silver, zinc, phenols, surfactants
Plastic fabricator	***Solvents***	Tetrahydrofuran, dichloromethane, acetone, IPA, benzyl chlorofuran

Exhibit 2-1. Types of Businesses and Typical Related Contaminants (continued)

Business	Likely Contaminants	Typical Analytes
Printer	***Solvents***, metals	BTEX, TCE, PCE, *cis*-1,2-DCE, vinyl chloride, turpentine, mineral spirits, silver
Railroad	***Petroleum, PAHs,*** solvents, paint, fungicides, insecticides	Creosote
Sawmill	***Petroleum***	Oils
Sheet metal works	***Metals,*** solvents	PCE, TCE, *cis*-1,2-DCE
Trunk manufacturer	***Solvents***, metals	
Upholstery cleaner	***Solvents***	TCE, PCE, *cis*-1,2-DCE, vinyl chloride
Welding	***Metals,*** solvents	Zinc, cadmium, beryllium, mercury, lead, PCE, TCE, *cis*-1,2-DCE

Notes: ***Bold/italic*** text indicates predominant contaminant, most likely to pose a problem.
BTEX = benzene, toluene, ethylbenzene, and xylenes
cis-1,2-DCE = *cis*-1,2-dichloroethene (daughter product of tetrachloroethylene)
IPA = isopropyl alcohol
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
PCE = tetrachloroethylene
TCE = trichloroethylene
Vinyl chloride = daughter product of tetrachloroethylene

Properties with domestic heating oil tanks were also identified from archived tax assessor records. These tanks are not required to be registered, and they are not included in the state UST databases. Properties on which the only potential source of contamination is a documented or suspected heating oil UST were eliminated from further consideration because heating oil releases typically involve small volumes of oil and heating oil has low mobility. Potential heating oil tanks are indicated in Attachment B, Exhibits B-6 and B-7. The potential presence of domestic heating oil USTs on properties adjacent to the alignment for the Bored Tunnel Alternative is indicated in Attachment C.

2.3.3 Site Screening – Current Approach

Businesses within the study areas that potentially used hazardous materials were evaluated in two steps. The first step was to assign a level of potential risk to the environment based on the type of business, how long it operated, and whether any environmental testing has been conducted. A 20-year operation period was used as a threshold in characterizing whether a business had been in operation a long time and, therefore, had more opportunities to contaminate the site. More releases would likely result in either a greater volume of contaminated soil or greater levels of contamination. The sites were differentiated as having either a low/moderate risk to the environment or a moderate/high risk to the environment. Sites that pose a potential risk to the environment were identified as sites of concern.

The second step was to rank each site based on its potential to adversely affect the project. Based on the site's proximity to the alignment for the particular alternative, the likelihood that the site would adversely affect the project, and the assigned level of impact based on the contaminants that may be present, the site was assigned a not likely, low, moderate, or high potential impact. Thus, for each site within the respective study areas, there is a risk to the environment classification and an impact level based on the contaminants that may be present at the site and the site's proximity to the particular alignment.

WSDOT's risk analysis requires that sites of concern be evaluated for risk to the environment, risk to the construction project, and WSDOT's liability, as described in *Guidance and Standard Methodology for WSDOT Hazardous Materials Discipline Reports* (WSDOT 2009). Although accomplished in steps that differ from WSDOT's steps for identifying sites of concern and potential risk, the current site screening and risk analysis approach incorporates WSDOT's criteria. The process outlined in the decision tree in Exhibit 2-2 was used to identify sites of concern and classify the risk posed by each of these sites to the environment. Each site of concern was then evaluated for its potential impact on the project sites.

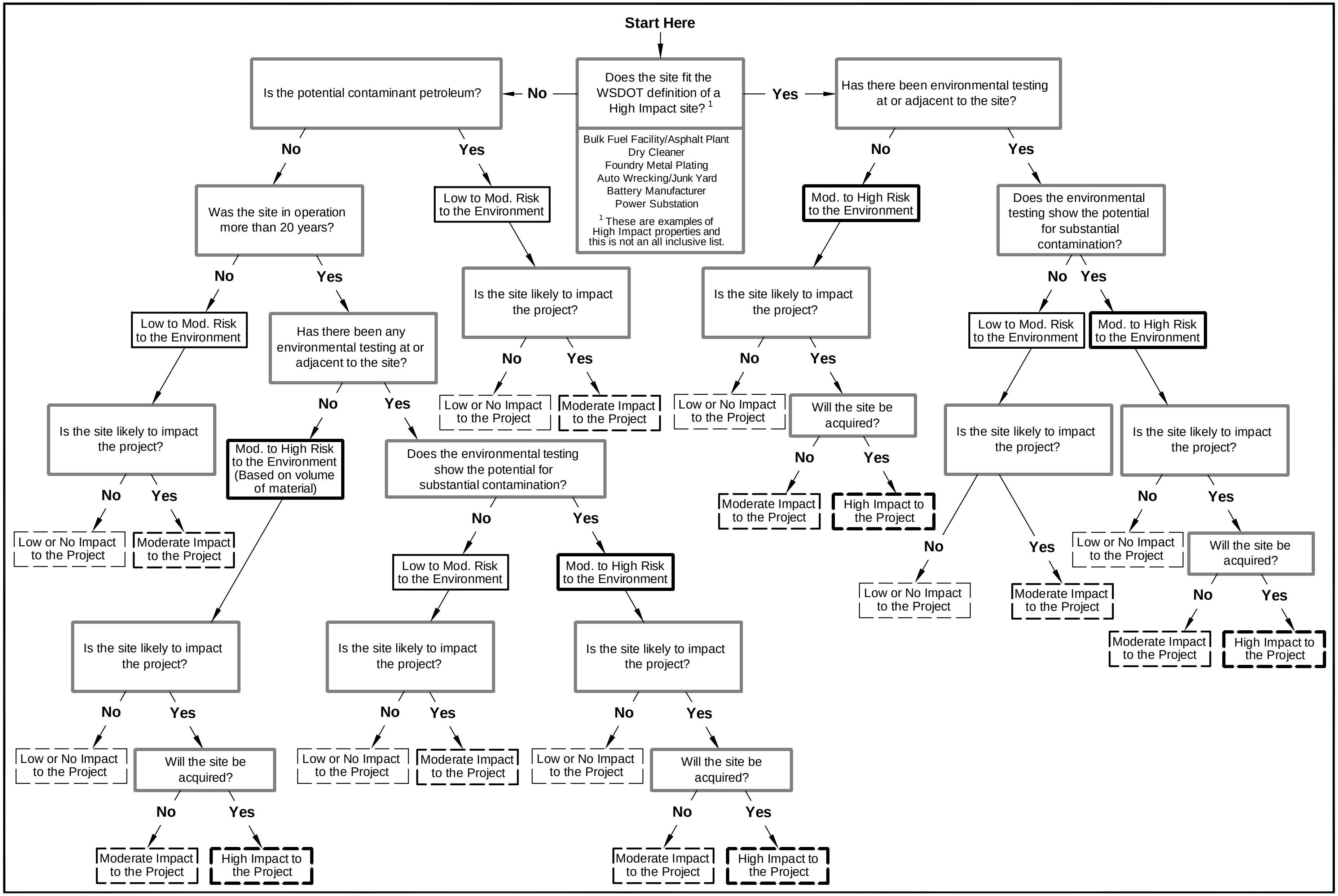
Only sites of concern that pose a risk to the environment <u>and</u> have a potential for adversely affecting the project were retained as "validated sites." Sites most likely to adversely affect the project meet one of the following criteria:

- The site is adjacent to the Bored Tunnel Alternative alignment at a portal or ramp, or it is adjacent to the entire length of the alignment for the Cut-and-Cover Tunnel Alternative or the Elevated Structure Alternative.
- The site overlies or is adjacent to the bored tunnel where the crown of the tunnel is less than 100 feet bgs. This includes sites north of the south portal to Yesler Way and sites south of the north portal to the intersection of Fourth Avenue and Bell Street.

In general, the criteria in Exhibit 2-3 were used to characterize the potential impact posed to the project.

WSDOT guidance (WSDOT 2009) defines sites with low, moderate, and high-impact as follows:

- **Low impact.** Low-impact sites are those where a potential concern exists because of known historical activities, but either the likelihood for the site to affect the project is low or the contamination was previously remediated. An example of a site with a low potential impact would be a property with a former or current gas station operation that is adjacent to the alignment. Large-scale excavation is not anticipated near the site.



Filename: J:\211\20447-098\21-1-20447-098 Decision Tree.dwg Date: 01-21-2011 Login: sac

Exhibit 2-2
Property Evaluation Decision Tree

Exhibit 2-3. Criteria for Characterizing Level of Impact

Potential Impact and Remediation	Proximity/Future Ownership	Category of Potential Environmental Risk
Low; remediation is straightforward.	Property is located adjacent to the project footprint.	Low to moderate
Moderate; remediation is straightforward.	Project is expected to acquire the site and/or have a temporary or permanent easement.	Low to moderate
Moderate; remediation is complex.	Property is located adjacent to the project footprint, but project is not acquiring the property.	Moderate to high
High; remediation is complex.	Project is expected to acquire the site or have a temporary or permanent easement, where the crown of the tunnel is less than 100 feet below ground surface.	Moderate to high

- **Moderate impact.** Moderate-impact sites are those where a concern exists because of known historical activities and/or the site has the potential to adversely affect the project, but there is no conclusive evidence. An example of a site with a moderate potential impact would be a property with a current or former gas station operation that would be acquired, and no site investigation has been conducted.
- **High impact.** High-impact sites are those where a concern exists because of known historical activities, contamination is known and extensive, and the site is likely to adversely affect the project. In general, high-impact sites are defined as properties that have a potential for substantial soil, groundwater, or sediment contamination, or properties for which the information necessary to predict remedial costs is lacking. Such a site may be contaminated over a large area by a single contaminant or over a smaller area by multiple contaminants. High-impact sites typically are large, have large volumes of contaminated materials, or have a long history of industrial or commercial use. An example of a site with a high potential impact would be a property that would be acquired and has been used by a dry-cleaning operation.

In the evaluation process, sites of concern that are very unlikely to have an impact on the project because of their lateral and vertical distance from the project area were designated as having no impact and were eliminated from further consideration. They still may pose a risk to the environment, but that does not carry through to an impact on the project.

In addition to the impact category, the potential remediation was assessed as either straightforward or potentially complex, as defined below:

- **Straightforward.** Sites characterized as having straightforward remediation are typically small to medium in size, and the potential contaminants are not extremely toxic or difficult to treat. Examples of straightforward sites are gas stations, auto repair shops, most USTs, aboveground storage tanks, buildings that contain ACM, or materials that contain LBP.

- **Complex.** Sites characterized as requiring complex remediation include sites likely to have widespread contamination or potential contaminants that are difficult to treat. Complex sites typically require additional research, investigation, and possibly regulatory involvement. Examples of complex sites are dry cleaners, wood treating operations, metal-plating facilities, or other operations that use or used large amounts of hazardous materials.

Remediation approaches have not been assigned to validated sites that would not be acquired for any of the build alternatives. In these cases, the property owner would be responsible for site cleanup. However, the site could still adversely affect the project because contaminants could migrate from the site and affect soil beneath or adjacent to the site.

The validated sites are discussed in Section 4.4.

2.3.4 Site Screening Before June 2009

In June 2009, WSDOT issued guidance for the preparation of hazardous materials evaluations. Although the terminology and evaluation process have changed since most of the sites were identified and ranked, the first step of evaluating risk to the environment is essentially the same, as described below. Therefore, because the same process was used to screen sites, sites evaluated before 2009 can be seamlessly integrated with sites screened after June 2009.

In 2003 and 2005, when most of the sites were identified, they were classified as either "reasonably predictable" (RP) or "substantially contaminated" (SC) based on the type of remediation that would be required if the site was contaminated. Each site was then assigned to a high-, moderate-, or low-impact category based on its proximity to each of the alternative alignments. Similar to the current risk evaluation procedure, this method initially evaluated all the sites for their potential effect on the environment independent of their proximity to the project area, followed by an evaluation of their potential impact on the project. Sites that would likely require remediation based on their historical land use were identified as sites of concern.

Sites where the likely contaminant is petroleum (e.g., gas stations and auto repair sites) were classified as RP because petroleum remediation is typically straightforward. Sites such as bulk fuel facilities, asphalt plants, dry cleaners, foundries/metal plating facilities, auto wrecking yards/junkyards, battery manufacturers, and power substations were classified as SC because they may be contaminated over a large area by a single contaminant or over a smaller area by multiple contaminants. SC sites typically are large, have a large volume of contaminated materials, or have a long history of industrial or commercial use. A 20-year operation period was used as the threshold in characterizing whether a business had been in operation a long time. Sites in operation for at least 20 years and on which the potential contaminant was something other than petroleum were classified as SC; sites in operation less than 20 years were classified as RP.

The decision process used to categorize environmental risk and potential project impacts posed by each site is illustrated in Exhibit 2-2. Under this revised risk evaluation procedure, sites formerly classified as RP would be considered to pose a low to moderate risk to the environment. Sites formerly classified as SC would be considered to pose a moderate to high risk to the environment.

Each site of concern was then evaluated for its likelihood to adversely affect each of the alternatives, based on the contaminants that may be present at the site and the site's proximity to the alignment, similar to the 2009 screening approach. Only sites of concern that pose a risk to the environment <u>and</u> have a potential for adversely affecting the project were retained as "validated sites."

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Chapter 3 STUDIES AND COORDINATION

This chapter summarizes the studies that were conducted to identify potentially hazardous materials that may be present within the study areas. Environmental studies were coordinated with geotechnical studies that were conducted to evaluate the preliminary design. The environmental data have been evaluated, and the findings are summarized in the *CT-15 Environmental Considerations Report* (Shannon & Wilson 2010a) and in this discipline report.

3.1 Historical Records Reviewed

Analysts reviewed the following information sources to identify historical uses of properties that are commonly associated with generation, storage, or transportation of hazardous materials. The historical records review was limited to the two study areas (proposed SR 99 alignment and adjacent areas within approximately 400 feet, or two city blocks). A review of historical records was conducted in 2004; additional review of historical records was conducted in 2009 to evaluate the study area for the Bored Tunnel Alternative. The historical land uses identified by the following historical records are discussed in detail in Chapter 4.

3.1.1 Washington State Archive Records

Analysts used the King County tax assessor archives to obtain information regarding building construction dates, heat sources, presence of underground tanks, property use, and ownership within the study areas. Records from approximately 1936 to 1972 were accessed at the regional branch of the Washington State Archives. Records after 1972 were accessed electronically.

The records are catalogued by city block. Typically, 12 to 14 lots and corresponding parcels were located within a block. Business property boundaries were mapped using parcel descriptions and identified as a potential site. Over time, many parcels have been combined. If the shape of the parcel had changed and suspect land use continued, the property was identified as a new site that overlaps other sites.

3.1.2 Sanborn Fire Insurance Maps

Historical Sanborn fire insurance maps are available for most of both study areas for intermittent periods between 1888 and 1969. Analysts used the Sanborn maps to identify historical businesses by name, exact location, and unique concerns for insurance underwriters, such as large fuel tanks and chemical hazards. Sanborn maps also display property addresses that were used to plot businesses identified by the search of the Polk directories.

3.1.3 Polk Directories

The Polk directories identify businesses by name, type of business, and address for the years 1938 to 1990. These directories, which can be searched by address, are excellent sources of information regarding area development and property uses over time. Analysts reviewed directories for Seattle for the years 1938, 1940, 1943–1944, 1951, 1956, 1960, 1965, 1970, 1975, 1980, 1985, and 1989–1990 at the Seattle Public Library.

Business addresses were evaluated to determine if the address corresponded with a business identified in either the archived tax records and/or the Sanborn maps. If the business had not been previously identified, it was recorded as a new site. The property boundary was based on historical parcel dimensions.

3.1.4 Aerial Photographs

Aerial photographs provide general information regarding the historical and current development within the study areas. Analysts reviewed black and white aerial photographs for both of the study areas dated 1936, 1946, 1951, 1956, 1961, 1966, 1970, 1974, 1979, 1985, and 1992 and color photographs taken in 2000 that were obtained from the WSDOT Photography Series Division and Walker & Associates (now Aero-Metric).

3.1.5 King County Tax Assessor Records

Analysts used current King County tax assessor records, obtained from the King County website, to confirm the age of the buildings, their current use and ownership, and their current heat source. Current tax assessor records were reviewed for the blocks underlying or immediately adjacent to the proposed SR 99 alignment within the study areas.

3.2 Regulatory Records Review

Analysts reviewed federal and state databases to identify former and current land uses that could result in the contamination of soil or groundwater. This preliminary list of sites of concern was screened further to identify sites with confirmed or suspected contamination within the study areas, as described in Section 2.3.1. The regulatory databases used to compile the preliminary list of sites are described in this section, along with the site elimination process.

The regulatory records review identified 186 total sites within study area for the Bored Tunnel Alternative, 108 of which were unique sites. A total of 205 sites were identified within the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives, 117 of which were unique sites. Some of the sites are included on more than one list.

Environmental Data Resources, Inc. (EDR) conducted a search of the databases and prepared a report (Attachment A) (EDR 2009). The search was conducted in accordance with the search distance requirements for a Phase I ESA (ASTM 1527). The sites identified in the EDR search are indicated in Attachments B, C, and G. As described in Section 2.3.1, some of the sites listed in the EDR report were excluded from further evaluation because they are unlikely to affect the project; these sites are indicated in Attachment B. The sites and unique sites within each study area that are listed in regulatory databases are summarized in Exhibit 3-1.

3.2.1 EPA Databases

Four EPA databases were searched.

Comprehensive Environmental Response, Compensation, and Liability Information System

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database contains data on potentially hazardous material sites that have been reported to EPA by states, municipalities, private companies, and privately owned sites. Sites listed in CERCLIS are either included on the National Priorities List (NPL) or proposed for inclusion on the NPL. Sites currently in the screening or assessment phase of the investigation for possible NPL inclusion may also be included in CERCLIS. One CERCLIS site was identified within the study areas. The facility received a No Further Remedial Action Planned (NFRAP) designation and is not being considered for NPL designation.

National Priorities List

The NPL database is a subset of CERCLIS that identifies more than 1,200 sites (nationwide) for priority cleanup under the Superfund program. No NPL sites were identified within the study areas.

Resource Conservation and Recovery Act Information

The RCRAInfo database contains selected information for sites that generate hazardous material or transport, store, treat, and/or dispose of hazardous material as defined by RCRA. The RCRAInfo database also identifies treatment, storage, and disposal (TSD) facilities with RCRA corrective action activity (CORRACTS). There are no TSD facilities listed within the study areas. There are 25 unique RCRAInfo sites within the study area for the Bored Tunnel Alternative, including large-quantity, small-quantity, and conditionally exempt generator sites. There are 24 unique RCRAInfo sites within the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. These sites have not been identified as sites with known or suspected contamination. A list of these generators is provided in Attachment B, Exhibit B-1.

Exhibit 3-1. Sites in Regulatory Databases Located Within the Study Areas

	Database																					
	Bored Tunnel Alternative Study Area											Cut-and-Cover Tunnel and Elevated Structure Alternatives Study Area										
	ERNS	RCRAInfo	LUST	VCP	CSCSL	ICR	HSL	Brownfield	CERCLIS-NFRAP	UST	Totals	ERNS	RCRAInfo	LUST	VCP	CSCSL	ICR	HSL	Brownfield	CERCLIS - FRAP	UST	Totals
Total Listings																						
RCRAInfo sites (Exhibit B-1)		33									33		30									30
ERNS (Exhibit B-2)	3										3	1										1
USTs removed from ground (Exhibit B-3)										24	24										25	25
Release sites (Exhibit B-5)			18	9	19	25	1				72			10	9	15	12					46
Release sites and UST sites (Exhibits G-1 and G-2)			5	4	9	3		1	1	3	26			17	11	26	18	2	1	1	2	78
Registered USTs (Exhibit B-4)										28	28										25	25
Totals	**3**	**33**	**23**	**13**	**28**	**28**	**1**	**1**	**1**	**55**	**186**	**1**	**30**	**27**	**20**	**41**	**30**	**2**	**1**	**1**	**52**	**205**
Unique Listings																						
RCRAInfo sites (Exhibit B-1)		25									25		24									24
ERNS (Exhibit B-2)	2										2											
USTs removed from ground (Exhibit B-3)										9	9										8	8
Release sites (Exhibit B-5)			13		19	8					40			6		15	6					27
Release sites and unique UST sites (Exhibits G-1 and G-2)			4		9	1				2	16			14		25	3				2	44
Registered USTs (Exhibit B-4)										15	15										14	14
Totals	**2**	**25**	**17**	**0**	**28**	**9**	**0**	**0**	**0**	**26**	**108**	**0**	**24**	**20**	**0**	**40**	**9**	**0**	**0**	**0**	**24**	**117**

Exhibit 3-1. Sites in Regulatory Databases Located Within the Study Areas (continued)

Notes: For a site on multiple lists (indicating a release), the priorities for assigning it to a "unique" list were as follows: CSCSL, HSL, LUST, VCP, ICR, CERCLIS-NFRAP, and Brownfield.

Brownfields are abandoned, idle, or underused commercial or industrial properties (a subset of CSCSL).

The individual sites indicated in this table are included on multiple lists; the totals will not equal the number of entries in the table.

CERCLIS-FRAP = Comprehensive Environmental Response, Compensation, and Liability Act – Further Remedial Action Planned

CERCLIS-NFRAP = Comprehensive Environmental Response, Compensation, and Liability Act – No Further Remedial Action Planned

CSCSL = Confirmed and Suspected Contaminated Sites List, including NFA (No Further Action) sites

ERNS = Emergency Response Notification System

HSL = Hazardous Sites List (a subset of CSCSL)

ICR = Washington Site Register of Independent Cleanup Reports

LUST = leaking underground storage tank

RCRAInfo = Resource Conservation and Recovery Act Information (large-quantity, small-quantity, and conditionally exempt generators)

UST = registered underground storage tank

VCP = Voluntary Cleanup Program

Emergency Response Notification System

The ERNS database contains information on reported releases of oil and hazardous substances. Two unique sites within the study area for the Bored Tunnel Alternative have reported spills. No unique sites are identified within the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. A complete list of ERNS sites is provided in Attachment B, Exhibit B-2.

3.2.2 Washington State Regulatory Databases

Five Ecology databases were searched. Most of the sites appear on more than one list: a list of potential release sites (LUST or CSCSL) and one or more of the lists identifying the program under which the remediation was accomplished (VCP, ICR, and/or LUST). USTs are also included as potential sites. Consequently, if the number of sites in each database is summed, the total will be more than the 108 unique sites on the five lists that were identified within study area for the Bored Tunnel Alternative. Similarly, 117 unique sites were identified in the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. USTs were also evaluated separately, as described in the Attachment C. If a potential or confirmed release occurred at the site, it would also be listed on one of the other Washington State regulatory databases.

Confirmed and Suspected Contaminated Sites List

The CSCSL contains state hazardous material site records—Washington's equivalent of CERCLIS. A total of 28 sites within the study area for the Bored Tunnel Alternative are included on the CSCSL, as indicated in Attachment G, and sites that were eliminated from further consideration are indicated in Attachment B, Exhibit B-5. A total of 41 sites were identified in the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. The potential hazard posed by one site was ranked for the Bored Tunnel Alternative, and two sites were ranked for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. These sites are included on Ecology's Hazardous Sites List.

Voluntary Cleanup Program List

The VCP list contains remedial action reports that Ecology has received from either the owners or the operators of the sites. These actions have been conducted with Ecology review but are not under an order or decree. The VCP list shows 13 sites in the study area for the Bored Tunnel Alternative and 20 in the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. These sites are indicated in Attachment G, and sites that were eliminated from further consideration are indicated in Attachment B, Exhibit B-5.

Washington Site Register of Independent Cleanup Reports

The ICR list contains remedial action reports that Ecology has received from either the owners or operators of the sites. These actions have been conducted without Ecology oversight or approval and are not under an order or decree. The ICR list includes 28 sites within study area for the Bored Tunnel Alternative and 30 within the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. These sites are indicated in Attachment G, and sites that were eliminated from further consideration are indicated in Attachment B, Exhibit B-5.

Leaking Underground Storage Tank Database

The LUST database is an inventory of reported LUST incidents along with the cleanup status and the affected medium (soil or groundwater). This database shows 23 LUST sites within the study area for the Bored Tunnel Alternative and 27 within the study area for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. These sites are indicated in Attachment G, and sites that were eliminated from further consideration are indicated in Attachment B, Exhibit B-5.

Underground Storage Tank List

The UST list identifies properties that have USTs registered with Ecology. The information includes operational status, removal status, and tank contents. Within the Bored Tunnel Alternative study area, a total of 28 tank sites are operating, were closed in place, or had a closure in process since 1996; the Cut-and-Cover Tunnel and Elevated Structure Alternatives study area had a total of 25 sites. The status of each tank (i.e., operational, closed-in-place, and closure-in-process) is indicated in Attachment B. Tank sites from which the tank has been removed are listed in Attachment B, Exhibit B-3 (a total of 24 sites) within Bored Tunnel Alternative study area and 25 sites within the Cut-and-Cover Tunnel and Elevated Structure Alternatives study area. These tank locations are not displayed on a graphical exhibit. Registered tanks that likely remain in the ground are displayed in Attachment C. If contamination was encountered at a UST, it is identified as a site because it also appeared on the LUST, CSCSL, VCP, or ICR lists.

3.3 Ecology Files Review

Analysts reviewed Ecology files to evaluate further the potential for the listed sites to affect the study areas and the project. The sites that were reviewed were selected based on their proximity to the project area. Files for CSCSL, ICR, VCP, and LUST sites were requested from Ecology. The files were reviewed in 2004, 2005, and June 2009. Site histories were updated in February and September 2010 to identify any change in condition. A summary of the reviewed Ecology files that indicated a potential to affect the project is included in Attachment G. Sites within the study areas that were eliminated from further consideration and the rationale for their elimination are indicated in Attachment B, Exhibit B-5.

3.4 Evaluation of Sites on Regulatory Lists

A regulatory database search was performed by EDR (2009) for documented, suspected, or potential release sites within a distance of 1 mile from the project footprint. Sites with documented releases are defined as those that appear in the regulatory databases as having reported a release of contaminants into the soil, sediment, or groundwater of a property. Other sites identified in the regulatory databases include generators of hazardous wastes (not necessarily indicating a release) and registered USTs.

Federal NPL and CERCLIS sites within 1 mile of the project footprint and state CSCSL, ICR, and LUST sites within ½ mile of the project footprints were identified. No NPL sites were identified that have a potential to adversely affect the project. One CERCLIS-NFRAP site that was identified was considered to have a moderate potential to adversely affect the project based on historical operations that likely involved solvent use.

Sites identified on state lists that are located more than two blocks (approximately 400 feet) from the project footprints were screened for potential groundwater contamination. No sites were identified that would likely affect the project study area. The eliminated sites are indicated Attachment B, Exhibit B-5.

There are 186 listed sites within study area for the Bored Tunnel Alternative, some of which are on multiple lists. Of the 108 unique sites identified, 52 were eliminated from the evaluation as being unlikely to affect the project. Similarly, 205 listed sites were identified within study area for the Elevated Structure and Cut-and-Cover Tunnel Alternatives; 117 of the sites are unique, and 46 were eliminated from further consideration. The site elimination was based on the following screening criteria:

- Sites listed solely in the RCRAInfo database (Attachment B, Exhibit B-1): 25 of 33 sites for the Bored Tunnel Alternative and 24 of 30 sites for the Elevated Structure and Cut-and-Cover Tunnel Alternatives. Inclusion on the RCRAInfo list indicates that a site uses or generates regulated materials as part of its business function, but it provides no indication of releases to soil or groundwater.
- Sites listed solely on the ERNS database (Attachment B, Exhibit B-2): two sites for the Bored Tunnel Alternative and no sites for the Elevated Structure and Cut-and-Cover Tunnel Alternatives. Inclusion on this list indicates that a spill has occurred on the site. The sites are not included on other lists; there is no indication of soil or groundwater contamination.
- Sites included on the UST list from which the tank has been removed (Attachment B, Exhibit B-3): 24 sites (total) within the study area for the Bored Tunnel Alternative. Of these 24 sites, 14 also appear on other lists

(LUST, VCP, CSCSL, and ICR) as potential release sites; therefore, they were retained for further evaluation. Eight of the remaining UST sites from which the USTS have been removed are unique to the UST list and were excluded from further evaluation; the other two sites that also appear on the RCRAInfo list were also excluded at this point (a total of 10 excluded sites). One of these initially excluded sites was evaluated further because of its historical land uses: dry cleaning, printing, and auto repair. This evaluation process identified nine UST sites that were excluded from further evaluation (see Exhibit 3-1). Registered USTs that are still underground are described in Attachment C. The same approach was used to evaluate USTs within the study area for the Elevated Structure and Cut-and-Cover Tunnel Alternatives (see Exhibit 3-1).

- Sites identified solely because of a registered UST that may still be in the ground (Attachment C, Exhibit C-2): 28 sites (total) within the study area for the Bored Tunnel Alternative. Of the 28 sites that have at least one tank that is still in the ground, 12 also have had a confirmed release (included on the LUST, CSCSL, or ICR list) and were retained for further evaluation. One other site that had a UST was retained because of the historical land use at the site. Consequently, 15 unique sites were excluded from further consideration. All registered tanks were evaluated separately to identify tanks that remain in the ground along the Bored Tunnel Alternative alignment (see Attachment C). The same evaluation was conducted for registered tanks within the study area for the Elevated Structure and Cut-and-Cover Tunnel Alternatives. The excluded sites are summarized in Attachment B, and Attachment C has been updated to include tanks identified exclusively within the study area for the Elevated Structure and Cut-and-Cover Tunnel Alternatives.

Of the remaining 56 sites in the study area for the Bored Tunnel Alternative, 11 are located downgradient of the Bored Tunnel Alternative alignment and are unlikely to affect the project. Of the remaining 56 sites, 29 are located upgradient or crossgradient of the alignment and have been excluded for a variety of reasons, including distance from the project area, distance to the tunnel crown, type of contaminant, apparent completion of remediation, and expected excavation depth for the Bored Tunnel Alternative in the area.

Of the remaining 71 sites within the study area for the Elevated Structure and Cut-and-Cover Tunnel Alternatives, 27 were eliminated based on a similar evaluation as that described for the Bored Tunnel Alternative. The excluded sites and the rationale for their exclusion are indicated in Attachment B, Exhibit B-5.

The step-by-step process used to assign risk to the environment posed by each of the sites is illustrated in Exhibit 2-2. The impact level is based on the contaminants that are present at the site and the site's proximity to the respective project areas. Exhibit 4-14 summarizes the number and distribution of validated sites that could potentially affect the project. Detailed information for each validated site is provided in Attachment G. Sixteen sites on regulatory lists have been identified for the Bored Tunnel Alternative, and 44 sites have been identified for the Elevated Structure and Cut-and-Cover Tunnel Alternatives. Because of the overlapping study areas, some sites are identified for all of the alternatives.

3.5 Windshield Surveys of the Study Area

Windshield surveys were conducted in June 2006 and July 2009 to identify current site uses in the study area that are likely to involve the use, treatment, storage, or disposal of hazardous materials and to verify the location of listed and orphan sites associated with the regulatory review, where possible. All observations were made from public areas. For the two tunnel alternatives, only the north and south portal areas were surveyed, along with the north and south areas for the Elevated Structure Alternative. The central areas for all build alternatives were not surveyed. In January 2010, the 2009 windshield survey of the north portal area for the Bored Tunnel Alternative was updated. The windshield survey of the south portal area conducted in 2009 included Alaskan Way S. to S. King Street; therefore, the south portal area was not resurveyed in 2010. All observations were made from public areas. Detailed site investigations were beyond the scope of this evaluation. Each property adjacent to the proposed SR 99 alignments within the study areas was viewed to compare the current tax assessor description of the site/buildings with observed site conditions. Findings from the windshield surveys are included in Chapter 4, and photographs for the Bored Tunnel Alternative are provided in Attachment E. These same blocks were also included in the surveys conducted for the other build alternatives.

3.6 Potential to Encounter Asbestos and Lead-Based Paint

ACM and LBP may be encountered in buildings or other structures that are demolished during project construction. The potential for ACM to release asbestos fibers into the environment depends on the asbestos content, condition, and friability of the material.[1] Asbestos was used widely in building materials until 1977, when laws regulating its use and disposal were enacted. In 1986, the Asbestos Hazard Emergency Response Act (AHERA) required education agencies to inspect their schools for ACM and prepare a management plan to prevent or reduce potential exposure to asbestos. The approach was to manage the asbestos

[1] A friable material can be crushed with hand pressure, so the fibers are readily released into the environment.

in-place. ACM removal was necessary only if the material was damaged or would be disturbed by a building demolition or renovation project. The 1994 National Emissions Standards for Hazardous Air Pollutants rule extended the standards to all buildings.

Buildings constructed before 1977 are presumed to have a high potential to contain ACM, whereas recent buildings are substantially less likely to pose a significant hazard due to asbestos. Asbestos can be found in a variety of older building materials, including exterior siding, roofing shingles, flooring, sprayed-on fireproofing, insulation, soundproofing, ceiling tiles, and texturing. Asbestos was also commonly used as a major component of heating systems, gaskets, pipe wrapping, wire duct lining, and brake linings in trucks and cars. ACM has been confirmed in the Battery Street Tunnel, as described in Section 3.7 (Taylor 2007).

Lead used to be added to paint for pigment and to improve the performance of the paint including its durability, drying speed, and resistance to moisture, which causes corrosion. However, lead is dangerous to humans, especially children under the age of 6 whose bodies are still developing. Lead damages the nervous system, stunts growth, and delays development. To protect the public, the U.S. Consumer Product Safety Commission banned lead-containing paint in 1977 (16 Code of Federal Regulations [CFR] 1303). Toys and furniture coated with LBP were also banned. This action was taken to reduce the risk of lead poisoning in children who may ingest paint chips or peelings. In 1978, the Occupational Safety and Health Administration promulgated standards for the potential exposure of workers to lead (29 CFR 1910.1025). These standards are particularly pertinent to workers performing maintenance on structures coated with paint (e.g., bridges, water towers, and ships) and demolition. Recognizing that all buildings constructed before 1978 may contain LBP, the EPA now requires all renovators who work in homes built before 1978 and disturb more than 6 square feet of LBP to be certified to remove the material (EPA 2010).

Because of their age, some of the buildings that would be acquired for the build alternatives have the potential to contain asbestos and LBP. Four buildings would be acquired under the Bored Tunnel Alternative. The Cut-and-Cover Tunnel Alternative and the Elevated Structure Alternative would each require the acquisition of 12 buildings (not the same buildings).

3.7 Environmental Site Assessments and Hazardous Material Surveys

In compliance with due diligence requirements, WSDOT conducted Phase I ESAs on three properties that it acquired for this project. A Phase II ESA was conducted on two of these properties to address recognized environmental conditions (RECs). Because these properties could still contain as-yet unidentified contaminants, they are identified as potentially contaminated properties in this discipline report. A hazardous materials survey of the Battery Street Tunnel has been conducted. Samples of soot have also been collected in the Battery Street Tunnel.

In July 2009, Sound Environmental Strategies Corporation conducted another Phase I ESA of a parcel owned by the BNSF Railway at 1550 Alaskan Way S., located south of S. Atlantic Street (Sound Environmental Strategies 2009a). The focus of the assessment was an easement area in the northern portion of the property, where a footing would be installed as part of Stage 2 of the S. Holgate Street to S. King Street Viaduct Replacement Project. The subject site is approximately 900 feet south of the southernmost proposed construction in S. Royal Brougham Way for the south tunnel portal of the Bored Tunnel Alternative. Site conditions identified during the Phase I ESA can be used as part of the overall documentation to identify types of contamination throughout the corridor. Findings relevant to the current study areas include (1) the widespread presence of fill materials that may be contaminated by metals, petroleum products, and/or PAHs, and (2) historical railroad operations. Such operations may have involved spills of hazardous materials from railcars, the presence of railroad ties treated with creosote, and the application of pesticides for weed control.

Shannon & Wilson conducted a limited Phase I ESA in March 2009 for the King County King Street Regulator Station (Shannon & Wilson 2009). A portion of this site may be used for a temporary construction easement. From 1904 to 1950, a metal works and plating business occupied the site. Before that period, the site was occupied by a lumber shed. The eastern edge of the property was occupied by a railroad line beginning no later than 1904. In addition, the area has been filled. The RECs include the metal works and plating operation, the presence of fill from unknown sources, and historic railroad use. As identified in other Phase I ESAs conducted for properties in the south area, the fill could be contaminated with metals, petroleum products, and/or PAHs, as well as substances from historical railroad operations.

In December 2009, Sound Environmental Strategies conducted five Phase I ESAs for properties on Blocks 40.1, 50.1, 60.3, and 70.4 (two sites) (Sound Environmental Strategies 2009b to 2009f). These properties are located between Mercer Street and John Street, directly west of SR 99. The identified RECs include heating oil USTs on the subject properties and adjoining/nearby properties; a hydraulic fluid leak from a hotel elevator system; and former dry cleaners, gas stations, and auto repair shops (see Section 4.3). One heating oil tank of note is a 9,950-gallon UST reportedly located beneath the right-of-way on Sixth Avenue N. between Harrison Street and Broad Street.

In September 2006, CDM completed a Phase I ESA for the U-Park located at 550 Alaskan Way S., Project Parcel Number S212 (CDM 2006a). The RECs include potential contamination of soil and groundwater with metals from former metal works that operated in the 1910s to 1920s and potential contaminants associated with the former use of the property by the railroad. A gas station that operated northeast of the property has a moderate potential to affect the property.

Phase I and Phase II ESAs were completed for the former Washington-Oregon Shippers Cooperative Association (WOSCA) and Gerry Sportswear properties located at 801 and 1051 First Avenue S., respectively (CDM 2006b). The Phase II ESA was completed in January 2007 (CDM 2007). As part of the Phase II ESA investigation, a geophysical survey was conducted to identify potential USTs, and 13 soil probes were completed to collect soil and groundwater samples for chemical analysis.

Based on the sample results from these properties, only soil appears to be contaminated with petroleum hydrocarbons. Diesel contamination was verified in soils in the central parking area of the WOSCA property, between a parking pay booth and the Gerry Sportswear building. In a soil sample collected at a depth of 4 feet bgs, diesel-range hydrocarbons were identified at a concentration of 10,000 milligrams per kilogram (mg/kg), greater than the MTCA Method A cleanup level of 2,000 mg/kg. There is no known source for the contamination, and it may have been a surface spill, which is consistent with activities at a railroad freight terminal, which is the historical site use. The MTCA Method A Unrestricted Land Use category of cleanup levels was used for the evaluation because it uses conservative assumptions. Land use along the alignment is mixed, with primarily industrial and commercial uses in the southern part of the project area and mixed residential use in the area surrounding the north portal.

In April 2008, GeoEngineers conducted a Phase I ESA of Whatcom Railyard for WSDOT (GeoEngineers 2008). The identified site extends from Walker Street to S. King Street and is located between Alaskan Way S. and the viaduct. The property is owned by the City and is leased to the BNSF Railway and the Union Pacific Railroad. Approximately the northern half of the Whatcom Railyard evaluated in the ESA is applicable to the current study. The ESA concluded that metals and petroleum products associated with rail operations might be present in the soil. Other applicable findings include the observation of black soil (likely indicative of petroleum) approximately 5 to 10 feet below the street elevation during construction of a building in 2008 at a property identified in this discipline report as Block 360.2. Historical land uses and other findings related to the adjacent properties are similar to those described in Section 4.3.

In October 2008, Pacific Rim Environmental, Inc., under subcontract to GeoEngineers, conducted a hazardous materials survey of the Battery Street

Tunnel (Pacific Rim Environmental 2008). The survey included testing for ACM, LBP, and universal waste. Under the Bored Tunnel Alternative, the disposal of tunnel lights and equipment removed from the tunnel during decommissioning could be regulated by the universal waste rule if polychlorinated biphenyls (PCBs) or mercury is present. As part of the survey, 60 samples of suspected ACM were tested. The conduits in the north- and southbound tunnels were found to contain asbestos. In addition, the metal-clad fire doors were presumed to contain asbestos. The interior painted surfaces of the Battery Street Tunnel were tested to determine whether lead is present in the paint at concentrations greater than 1.0 milligram per square meter (mg/m^2). LBP was identified on all painted fire doors, painted fire cabinets, and the long yellow painted lane stripe along the barrier that separates the north- and southbound lanes. Low concentrations of mercury were found in the lamps; therefore, their disposal would be regulated. Based on the age of the light fixtures as determined by the attached stickers, the capacitors should not contain PCBs at concentrations greater than 50 parts per million (ppm), per labeling requirements of the Toxic Substances and Control Act. PCBs at a concentration of 2 ppm are regulated in Washington State. If there is no attached sticker, the capacitor should be treated as a PCB-containing fixture.

In October 2007, the WSDOT Hazardous Materials and Solid Waste Program collected six composite samples of soot from the ceiling of the Battery Street Tunnel (Taylor 2007). The sampling was performed to support a determination of health and safety risks associated with disturbing the soot. The samples were analyzed for petroleum; benzene, toluene, ethylbenzene, and xylenes (collectively known as BTEX); carcinogenic polycyclic aromatic hydrocarbons (cPAHs); eight RCRA metals; and asbestos. Concentrations of metals (arsenic, cadmium, and lead), cPAHs, and oil in all samples exceeded the MTCA Method A cleanup levels (except for arsenic in two of the samples). Based on the results of the Toxicity Characteristic Leaching Procedure (TCLP) analysis, five of the six samples contained lead concentrations greater than the characteristic dangerous waste criteria. One sample also had a cadmium concentration that exceeded the characteristic dangerous waste criterion. None of the samples contained detectable concentrations of asbestos. The study recommended that soot from the Battery Street Tunnel be handled and disposed of as dangerous waste.

In March 2004, Landau Associates collected a composite sample of grit and dust in the storage area located on top of the former operator's room within the Battery Street Tunnel (Landau 2004). The sampling was performed to support a determination of health and safety risks associated with disturbing the dust. The samples were analyzed for gasoline, BTEX, cPAHs, eight RCRA metals by TCLP methods, and asbestos. Constituents were detected in the dust; however, the concentrations were less than the dangerous waste criteria. Asbestos was not detected. A paint chip collected from an overhead duct near the entrance ladder to the storage area was tested for total lead, which was detected. The recommendations included vacuuming up the dust and grit and disposing of it at a solid waste landfill before conducting any work that would disturb the dust and grit. If work involves disturbing paint similar to that found flaking off the air duct, air monitoring for lead and particulates was recommended. Additional testing would be needed to determine whether lead in the paint is present at concentrations that would exceed the dangerous waste criteria.

3.8 Subsurface Explorations

Project geologists conducted a field exploration program along the alignments to obtain geotechnical data in the locations of the proposed structures. Samples collected during the geotechnical field explorations were chemically analyzed at an environmental laboratory. Specifically, selected soil and groundwater samples were analyzed to identify contaminants that may affect the handling, disposal, or treatment of the respective media.

Soil samples collected by means of borings and Geoprobes® within 200 feet of the alignments were evaluated. The exploration locations are shown on Exhibit 4-6.

Environmental conditions and considerations that may affect the construction methods and costs of the bored tunnel, cut-and-cover tunnel segments, and retained cut approaches are discussed in the *CT-15 Environmental Considerations Report* (for the Bored Tunnel Alternative) (Shannon & Wilson 2010a). An amendment to the report summarizes the findings of an environmental investigation performed near the proposed location of the Bored Tunnel Alternative north tunnel operations building. The purpose of the investigation was to assess the western extent of solvent contamination from a former dry-cleaning operation with documented soil and groundwater contamination. Summaries of the borings and groundwater monitoring wells that were evaluated and the analytical testing that was performed are provided in Chapter 4 and Attachment F, Exhibits F-1 and F-2. Details of the drilling and sampling methods, analytical results, analytical laboratory reports, groundwater measurements, historical sources of contamination, and soil conditions are included in the following reports:

- *Geotechnical and Environmental Data Report – SR 99: Alaskan Way Viaduct Project, Seattle, Washington* (Shannon & Wilson 2002)
- *Geotechnical and Environmental Data Report – SR-99: Alaskan Way Viaduct and Seawall Replacement Project, Seattle, Washington* (Shannon &Wilson 2005a)
- *Utility Geoprobe Report – SR-99: Alaskan Way Viaduct and Seawall Replacement Project, Seattle, Washington* (Shannon & Wilson 2006)

- *Geotechnical and Environmental Data Report, Electrical Utility Explorations – SR-99: Alaskan Way Viaduct and Seawall Replacement Project, Seattle, Washington* (Shannon & Wilson 2007a)
- *Geotechnical Data and Engineering Report for TS&L Studies – SR 99: Alaskan Way Viaduct Project, Seattle, Washington* (Shannon & Wilson 2007b)
- *Geotechnical and Environmental Data Report, Phase 1 Archeological Explorations – SR 99: Alaskan Way Viaduct and Seawall Replacement Project, Seattle, Washington* (Shannon & Wilson 2007c)
- *Geotechnical Data and Engineering Report, Phase 1 Electrical Utility Explorations* (Shannon & Wilson 2007d)
- *Geotechnical Data and Engineering Report – S. Holgate Street to S. King Street Viaduct Replacement Project* (Shannon & Wilson 2008a)
- *Geotechnical and Environmental Data Report – SR 519 Intermodal Access Project* (Shannon & Wilson 2008b)
- *Environmental Considerations Report – S. Holgate Street to S. King Street Viaduct Replacement Project* (Shannon & Wilson 2008c)
- *Geotechnical and Environmental Data Report, Central Waterfront Tunnel* (Shannon & Wilson 2010b)
- *Interim Letter CT-6, Geologic Characterization Report (GCR) – Central Waterfront Tunnel* (Shannon & Wilson 2010c)
- *CT-15 Environmental Considerations Report – SR 99 Bored Tunnel Alternative* (Shannon & Wilson 2010a)
- *Draft Environmental Investigation Report: North Access Environmental Explorations – SR 99 Bored Tunnel Alternative Design-Build Project* (Shannon & Wilson 2010d)

3.8.1 Soil Sampling and Analysis

Environmental sampling and testing of soil were performed along each alignment, focusing on areas of excavation and soil improvement. For the Cut-and-Cover Tunnel Alternative, samples were collected from the ground surface to the proposed excavation depth. Although the center section of the Elevated Structure Alternative alignment would not be excavated, significant spoils would be generated during ground improvement activities along the waterfront and seawall. Environmental testing for the Bored Tunnel Alternative was conducted at both portals and at the proposed depth of the bored tunnel.

Soil samples were analyzed for a broad range of contaminants based on the current or historical uses of nearby properties and/or previous sampling data. The soil samples were analyzed for one or more of the following: gasoline-, diesel-, and oil-range petroleum hydrocarbons; VOCs; PCBs; PAHs; and metals. One or more chemical tests were conducted on 1,400 soil samples. In addition, pH measurements were collected for 900 soil samples throughout the alignments to evaluate corrosive properties of the soil.

The chemical analyses were performed by CCI Analytical Laboratories Inc. of Everett, Washington; OnSite Environmental Inc. of Redmond, Washington; and Fremont Analytical of Seattle, Washington. Corrosion testing was performed by AmTest Inc. of Kirkland, Washington. The findings are provided in the *CT-15 Environmental Considerations Report* (Shannon & Wilson 2010a).

3.8.2 Groundwater Sampling and Analysis

Groundwater from each monitoring well was analyzed for a variety of potential contaminants, depending on the results of the soil testing, adjacent land use, and general location. The chemical analyses included VOCs; gasoline; diesel; PAHs; methane; total sulfides; total and dissolved metals, including arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc; and general water quality parameters. A total of 290 groundwater samples were collected from 176 monitoring wells or Geoprobes®. These findings are provided in the *CT-15 Environmental Considerations Report* (Shannon & Wilson 2010a).

Most of the chemical analyses of the groundwater samples were performed by CCI Analytical Laboratories Inc., OnSite Environmental, and Fremont Analytical. The methane analyses were performed by OGW Research Labs Inc. of Tukwila, Washington, and Fremont Analytical.

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Chapter 4 AFFECTED ENVIRONMENT

The study area for the Bored Tunnel Alternative extends north along Alaskan Way from about S. Atlantic Street to approximately Marion Street and then extends northeast to First Avenue. The bored tunnel alignment continues under First Avenue north to approximately Pine Street, where it curves eastward to a northern access site located at Sixth Avenue N. and Thomas Street. The northern limit of the study area for the Bored Tunnel Alternative is Aloha Street. The study area for both the Cut-and-Cover Tunnel Alternative and the Elevated Structure Alternative generally follows the SR 99 alignment from S. Royal Brougham Way on the south to Aloha Street. The study area also includes the waterfront from approximately S. Washington Street north to Broad Street.

The study areas pass through highly developed industrial and commercial areas of Seattle that were first developed between the 1870s and the early 1900s and have a long and varied land use history. Because of the industrial and commercial use of this area, hazardous materials may have been released into the surrounding environment from a wide range of sources. In addition, the placement of fill and the construction of roads and piers may have adversely affected environmental conditions in the southern and central waterfront portions of the study areas.

The physical environment in the study areas must be considered in evaluating the extent of potential contaminant releases. The most important characteristics of the physical environment are the soil and groundwater conditions in and near the project footprint. These physical characteristics affect the potential for vertical and lateral migration of contaminants and, therefore, the potential for contamination from nearby releases to migrate to soils within the project footprint or to be in groundwater encountered during construction. The presence of hazardous materials in the soils or groundwater could have broad implications for the construction approach and costs of the build alternatives.

The following discussion of the affected environment summarizes the physical environment of the study areas, field data from exploration programs, historical land uses, and the potential and known distribution of contaminants in the study areas. The study areas for the Bored Tunnel Alternative and the Cut-and-Cover Tunnel and Elevated Structure Alternatives shown in Exhibits 4-11, 4-12, and 4-13 are discussed from south to north. Sites shown in Exhibits 4-11, 4-12, and 4-13 are identified based on historical land use and regulatory lists that document suspected or confirmed contaminant releases. Data from the field exploration program were used to support the site identification; however, no sites were identified based solely on contaminants detected in soil and or groundwater samples collected as part of the exploration program. The site-specific historical and regulatory information shown in Exhibits 4-11, 4-12, and 4-13 is also provided in Attachment D, Exhibit D-1.

4.1 Physical Environment

This section describes the physical environment and how it relates to the movement of contaminants. The physical environment within the study areas varies substantially from south to north and from the waterfront to the east.

The south area and the waterfront are underlain by 30 to 90 feet of recent deposits of sand and silt, including fill up to 50 feet thick. The fill contains refuse and substantial amounts of wood debris such as sawdust and creosote-treated piles. Fill along the waterfront ranges from 15 to 50 feet thick. Till or till-like material is encountered for 15 to 60 feet bgs beginning at Pike Street and extending south. North of Pike Street, the fill and beach deposits are underlain by sand and gravel. The water table in the south area is approximately 2 to 12 feet bgs, and along the waterfront, it is approximately 8 to 12 feet bgs. The water table near the waterfront fluctuates with the tide. The north area is underlain by up to 40 feet of interlayered fine-grained and coarse-grained soils upon which groundwater is locally perched. These soils are underlain by very dense sand and gravel. The regional water table is approximately 70 to 80 feet bgs at the north portal of the bored tunnel.

The movement of a contaminant is influenced by the subsurface conditions and the chemical and physical properties of the contaminant, including its density, concentration, vapor pressure, and solubility in water. A contaminant may migrate as a pure liquid or as a dissolved constituent in groundwater. Consequently, understanding groundwater movement is the primary means of assessing potential contaminant migration pathways.

Groundwater flows readily through coarse-grained soils such as sand and gravel. However, it does not flow as readily through fine-grained soils, such as silt and clay, or through till, which is a mixture of silt, clay, sand, and gravel deposited and consolidated by glaciers.

Liquid contaminants on or near the ground surface may move downward through coarse-grained soils. This movement is typically enhanced by infiltration of precipitation or other surface water, which can either physically transport the contaminant or carry it downward in solution. Similarly, a solid contaminant can be mobilized downward into the soil column when it is dissolved in water. Contaminants that move downward to the shallow groundwater behave differently, depending on their solubility in water and their weight relative to the weight of water.

Contaminant behavior varies according to the characteristics of the contaminant and the site conditions:

- Contaminants with a high vapor pressure volatilize in the unsaturated zone, resulting in vapor movement in the subsurface.
- Contaminants that are soluble in groundwater (such as some solvents) tend to dissolve and move in the direction of groundwater flow within coarse-grained soils.
- If the contaminant is not highly soluble in water and is lighter than water (such as oil and gasoline), it can float on the surface of the groundwater.
- If the contaminant is not highly soluble or is present in concentrations that exceed its solubility in water and is heavier than water (such as creosote and some dry-cleaning solvents), it can sink through the water column, moving downward until it reaches the fine-grained soil that separates shallow groundwater and deep groundwater. Dense solvents can migrate through clay and till.

Repeated glaciations (glacial events) of the region during the last million years strongly influenced the present-day topography, geology, and groundwater conditions in the Program area. The topography is dominated by a series of north-south-trending ridges and troughs formed by glacial erosion and sediment deposition. Puget Sound, Lake Washington, and other large water bodies now occupy the major troughs. The study areas are underlain by over 1,500 feet of glacial and nonglacial sediments overlying bedrock. Many of the glacial and nonglacial sediments have been glacially overridden, which means that the soils were compacted by the weight of overriding glacial ice as the glaciers advanced through the region. Because of repeated glaciations, the distribution of these sediments is complex. Each glaciation deposited new sediments and partially eroded previously deposited sediments. During intervening periods when glacial ice was not present, normal stream processes, wave action, and landslides eroded and reworked some of the glacially derived sediments, further complicating the geologic setting.

Groundwater flow in the Seattle area is controlled by this complex distribution of fine- and coarse-grained deposits, local topography, and areas where precipitation recharges the aquifers. Groundwater recharge typically occurs in the upland areas of Seattle. From there, it flows downward to discharge into areas that include Elliott Bay and Lake Union.

4.1.1 South Area

Build Alternatives

About the first 400 feet of the roadway south of the bored tunnel headwall would be within a cut-and-cover structure. The southbound roadway would then extend in a retained cut for about 800 feet until reaching existing grade, while the northbound (lower) roadway would continue in a cut-and-cover tunnel for about 650 feet and then in a retained cut for about 400 feet before reaching existing grade.

Similarly, the cut-and-cover stacked tunnel would transition to a side-by-side roadway. This roadway would extend about another 550 feet in a retained cut before reaching existing grade north of S. Royal Brougham Way. For both tunnel alternatives, on- and off-ramps would also be constructed in retained cuts on either side of the side-by-side main roadway. The retained cuts and cut-and-cover sections of the roadway and ramps would likely be supported by diaphragm walls, such as secant pile walls or slurry walls. Each of these two alternatives would require a tunnel operations or maintenance building constructed near S. Dearborn Street.

The roadway for the Elevated Structure Alternative would transition from an aerial structure at the north end of the south area to retained fill that returns to grade north of S. Royal Brougham Way.

Subsurface Conditions

Along the south area, recent sand and silt deposits approximately 30 to 90 feet deep overlie glacially overridden sand, gravel, and silt. The recent sand and silt soils consist of fill soils of variable compositions; sand, fine sand, and silt deposited by the Duwamish River; and sandy beach soils. Below the recent deposits lie approximately 80 to 100 feet of glacially overridden silt, sand, and gravel. The bored tunnel would extend primarily through glacially overridden soil deposits. Between S. Dearborn Street and Yesler Way, the bored tunnel alignment is west of the existing viaduct. In this area, the subsurface conditions consist of approximately 30 to 40 feet of recent sand, gravel, and silt deposits overlying glacially overridden soils. The fill soils in the vicinity of Yesler Way contain wood debris layers up to 20 feet thick. The glacially overridden deposits underlying the recent deposits in this area consist primarily of very dense till and till-like sand and gravel.

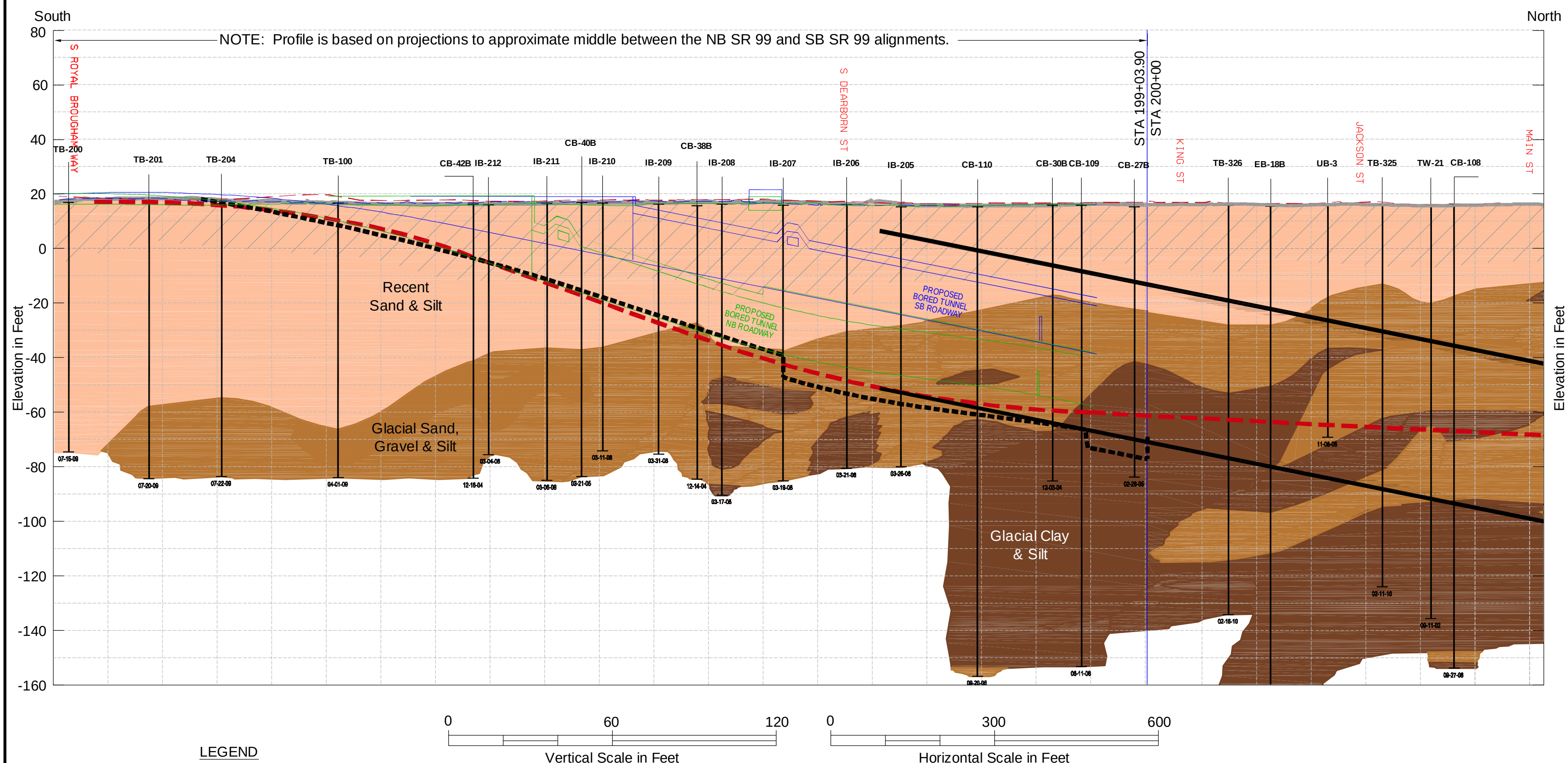
The lower portion of the fill generally consists of clean to silty, fine, and fine to medium sand with abundant organic material and organic-rich seams. This material appears to have been hydraulically placed and includes relatively little refuse and debris. The upper portion of fill in the south area and along the waterfront consists of granular or cohesive material that was excavated from surrounding areas of higher elevations and dumped and/or sluiced into place in the early 1900s to raise the grade to its current elevation. The upper part of the fill, which is typically 20 to 30 feet thick, includes a wide variety of refuse, such as cinders, brick, glass, concrete, and abundant wood debris, including sawdust and treated timber piles or logs. The depth and extent of the wood debris varies along the alignment. According to historical information, the northern half of the south area is located near the former site of a large sawmill (Yesler's Mill). There were likely widespread deposits of floating wood, piles for pier structures, and wood debris in this area before fill was placed in the area around 1900. Coal (cinders) has also been identified in the fill and may be associated with a former coal pier at S. King Street (Shannon & Wilson 2010c). The fill also contains debris that is likely from the Great Seattle Fire of 1889. In addition to debris, the fill contains low to moderate levels of contaminants, as discussed in Sections 4.2 and 4.3 (Shannon & Wilson 2010a). A profile of subsurface conditions in the south area and the proposed excavations is shown in Exhibit 4-1.

Shallow groundwater was first encountered at a depth of approximately 2 to 12 feet bgs; deeper groundwater was encountered in a thin layer of coarse-grained water-bearing soil at approximately 30 to 50 feet bgs in the vicinity of the south portal area. Shallow and deeper groundwater zones are separated by fine-grained soils that impede the hydraulic connection between the shallow and deeper groundwater. Fine-grained soils and till occur below the deeper groundwater zone. Groundwater flows predominantly toward Elliott Bay.

4.1.2 Central Area

Bored Tunnel Alternative

North of Yesler Way, the bored tunnel would extend beneath buildings until about University Street, where it would be located beneath First Avenue. The tunnel would continue along First Avenue and then turn north near Stewart Street until it ends near the intersection of Sixth Avenue N. and Thomas Street. The bored tunnel would be approximately 1.76 miles long and 56 feet in diameter (outside diameter of tunnel). At the south portal, the tunnel invert would be about 75 feet bgs. The maximum depth of the tunnel invert (about 270 feet bgs) would be located near Virginia Street. At the north portal, the tunnel invert would be about 90 feet bgs. The roadway in the bored tunnel would be a double-level configuration, with the southbound lanes on the upper level and the northbound lanes on the lower level. The Elliott Bay Seawall would be rebuilt as a Program element, but it is not considered part of the Bored Tunnel Alternative.



LEGEND

- Engineered and Non-Engineered Fill
- Recent Sand & Silt
- Glacial Sand, Gravel, & Silt
- Glacial Clay & Silt
- Proposed Bored Tunnel Southbound Roadway
- Proposed Bored Tunnel Northbound Roadway
- Limits of Proposed Bored Tunnel
- Approximate Bottom of Bored Tunnel Excavation
- Approximate Bottom of Slab for Cut-and-Cover Tunnel Alternative
- Approximate Ground Surface for Cut-and-Cover Tunnel Alternative

NOTES

1. Existing grade adapted from City of Seattle GIS data files *"topo_all.dwg"* received 3-11-02. Proposed structure based on *"North Portal-Geo_XSection _SH.dgn"* provided by Parsons Brinckerhoff 6-3-10. Cut and cover bottom of slab is taken from *"AWV Cut & Cover Tunnel Plans_SDIS Update Aug 2010.pdf"* and projected eastward approximately from 30 to 100 feet onto the bored tunnel alignment.
2. This profile is based on subsurface explorations performed through September 2010. Variations may exist between this profile and actual conditions.
3. Proposed roadway structures shown are approximate.
4. Vertical Datum: NAVD88.

Filename: J:\211\20447-098\21-1-21400-025 Bored Tunnel Profile_Simplified.dwg Layout: EIS South Area Date: 01-21-2011 Login: sac

GENERALIZED SUBSURFACE PROFILE ALONG SOUTH AREA

Exhibit 4-1
Sheet 1 of 1

Cut-and-Cover Tunnel and Elevated Structure Alternatives

The proposed alignments for the Cut-and-Cover Tunnel and Elevated Structure Alternatives in this area are located between the Elliott Bay Seawall and the Alaskan Way Viaduct. At approximately Pike Street, the alignments follow the path of the existing SR 99, with the construction of retained cut, aerial, and cut-and-cover sections to join the Battery Street Tunnel. The Battery Street Tunnel would be improved with wider portals, improved ventilation, and deeper tunnel entrances for greater vertical clearance.

For the Cut-and-Cover Tunnel Alternative, the stacked cut-and-cover tunnel along the waterfront would be approximately 90 feet wide and extend to a maximum depth of about 86 feet bgs. The Elliott Bay Seawall would be replaced as an integral part of the cut-and-cover tunnel.

Under the Elevated Structure Alternative, the Elliott Bay Seawall would be rebuilt from S. Jackson Street north to Broad Street. Ground improvement for the seawall would affect a 40-foot-wide area and extend into native soil that is between 20 and 50 feet bgs. No additional ground improvement would be required for the seawall where it is adjacent to the elevated structure. The elevated structure would likely be supported on drilled shafts that would extend to native soil. Shallow soils would be excavated during utility relocation.

Subsurface Conditions

Study Area Uplands

North of Yesler Way, the bored tunnel would extend beneath downtown Seattle at depths of more than 100 feet bgs. Fine-grained and coarse-grained soils are found along the alignment in this area.

At the south end of the bored tunnel alignment and along the waterfront sections of the Cut-and-Cover Tunnel and Elevated Structure Alternatives, groundwater is encountered within the fill about 8 to 12 feet bgs. The depth to water increases to the north and east (inland) to about 150 feet bgs near Lenora Street because of the increase in the ground surface elevation. North of Lenora Street, the depth of the water table decreases as the ground surface elevation decreases, with a depth to the water table of about 70 to 80 feet near Thomas Street. The direction of groundwater flow is predominantly toward Elliott Bay. In the northern portion of the bored tunnel, near the Battery Street Tunnel, till or fine-grained soils are often found at or near the ground surface. These low-permeability soils reduce the amount of precipitation that infiltrates the ground surface; consequently, downward migration of contaminants would be impeded. Shallow groundwater is encountered infrequently and, when encountered, is found as small zones perched on top of fine-grained soils.

Waterfront

The Cut-and-Cover Tunnel and Elevated Structure Alternatives would be constructed along the waterfront. A profile of subsurface conditions in the central area is shown in Exhibit 4-2. The soil deposits along the waterfront are affected by the Duwamish River, Elliott Bay, and the hills of Seattle. Beach deposits in Elliott Bay were reworked and then overlain by alluvial deposits from the Duwamish River and landslide debris from higher ground to the east of the shoreline. In some areas, these deposits were also interbedded with each other (alternating thicknesses of beach, alluvial, and landslide deposits). The area of the proposed cut-and-cover tunnel or elevated structure along the waterfront is underlain by glacially overridden soils at depths ranging from about 10 to 80 feet bgs.

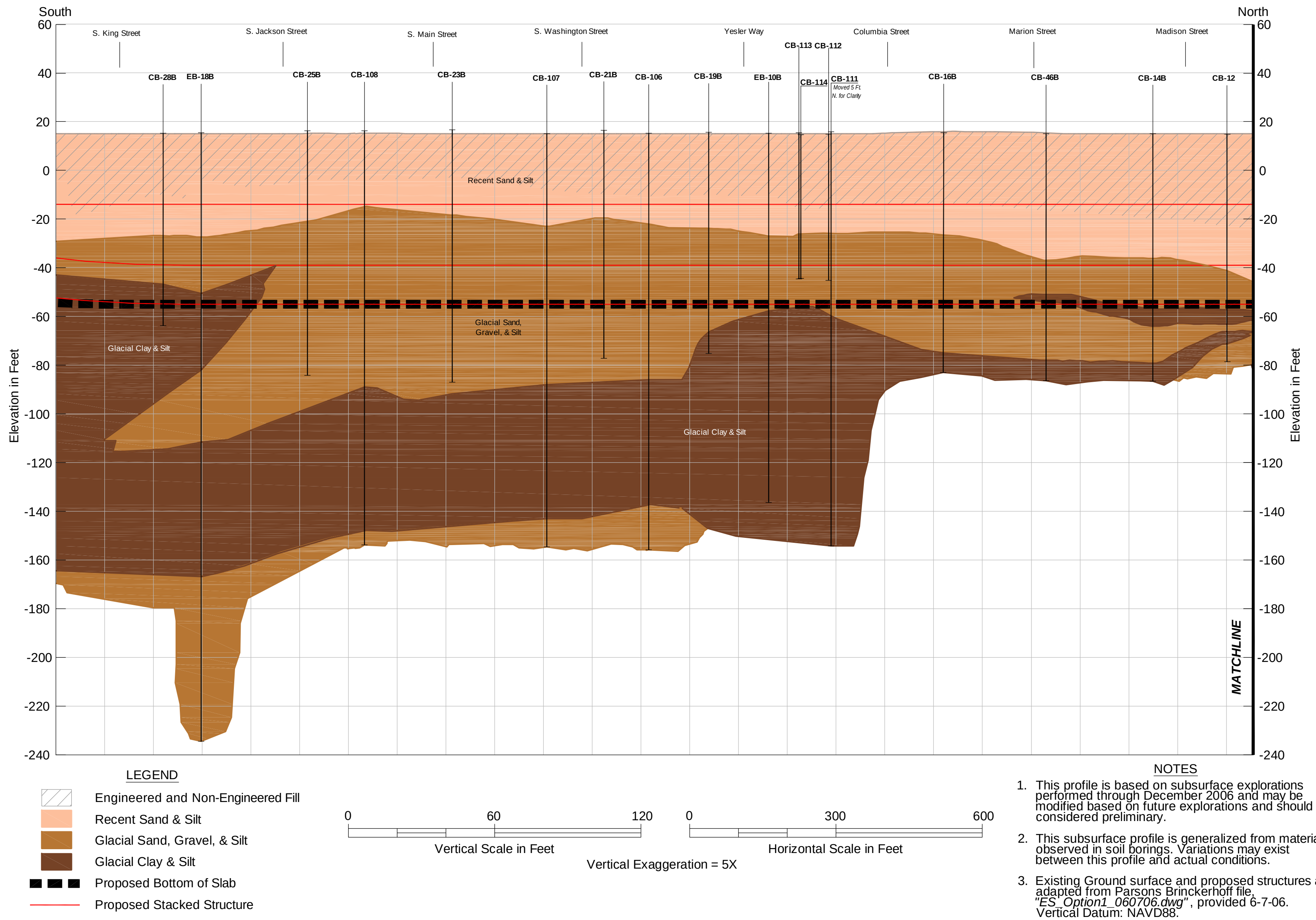
The glacially overridden soils are overlain by looser or softer soils that have not been glacially overridden and include fill, alluvium, estuarine, beach, landslide, and reworked deposits. Typically, the fill is thinner at the south end of the segment and generally thickens to the north. Fill thickness along the west side of the alignment ranges from 15 to 50 feet and is roughly 10 to 20 feet thicker than the fill deposits along the east side. The thickest fill deposits are located between Madison Street and University Street. The local fill contains scattered to abundant wood debris, including creosote-treated piles (vertical grain), driftwood (cross-grain), and sawdust (as thick as 20 feet), and other debris, as discussed for the south area.

Existing North Viaduct (Pike Street to South Portal of Battery Street Tunnel)

A generalized subsurface profile along the portion of the alignment (for the Cut-and-Cover Tunnel and Elevated Structure Alternatives) that would replace the existing viaduct is shown in Exhibit 4-3. The existing viaduct between Pike Street and the south portal of the Battery Street Tunnel extends up a hillside where a complex series of glacially overridden soils are present. Near the base of the hill, recent deposits typically consist of fill deposits and recessional soil deposited after the glaciers receded (not overridden). Very dense or very hard, glacially overridden soils are located at depths ranging from as much as 45 feet bgs near the base of the hill to only a few feet bgs in the upland areas near the south portal of the Battery Street Tunnel.

Battery Street Tunnel

The soil along the Battery Street Tunnel consists of about 10 feet of fill, landslide deposits, and gravel and sand and silt deposited when the glacier receded that are not glacially overridden. A profile of the subsurface conditions is shown in Exhibit 4-4. The depth to the top of glacially overridden deposits increases to about 30 feet bgs at the south portal of the tunnel. Along the central and north portions of the tunnel, clays, silts, and fine sands dominate the subsurface soils,



NOTES

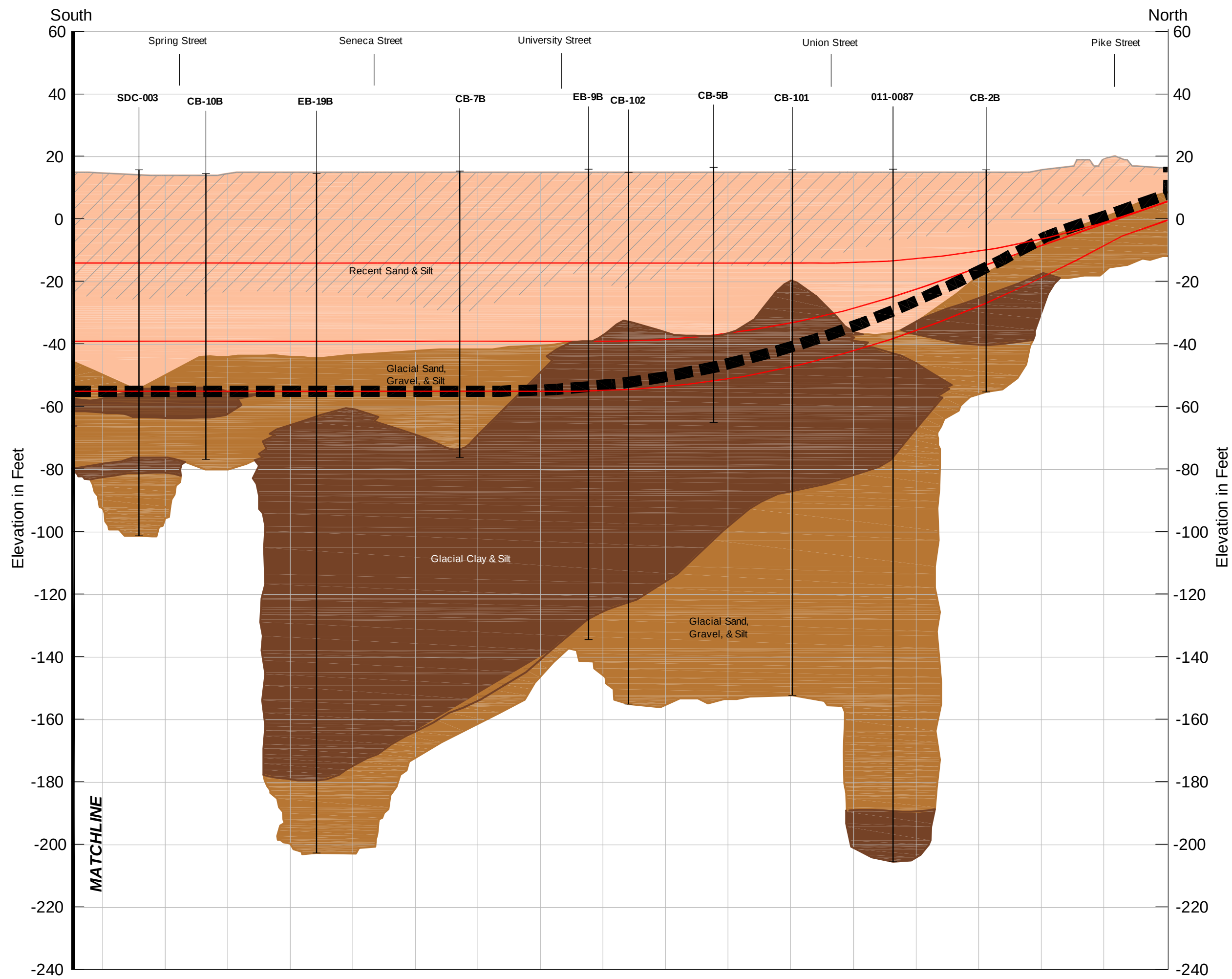
1. This profile is based on subsurface explorations performed through December 2006 and may be modified based on future explorations and should be considered preliminary.
2. This subsurface profile is generalized from materials observed in soil borings. Variations may exist between this profile and actual conditions.
3. Existing Ground surface and proposed structures are adapted from Parsons Brinckerhoff file, *"ES_Option1_060706.dwg"*, provided 6-7-06. Vertical Datum: NAVD88.

Filename: J:\211\20447-098\21-1-20501-020 Profile Cut-andCoverElevated Structure_Simplified.dwg Layout: EIS (1) Date: 12-01-2010 Login: Sandy Cottrell

GENERALIZED SUBSURFACE PROFILE ALONG THE CENTRAL CUT-AND-COVER TUNNEL AND ELEVATED STRUCTURE

Exhibit 4-2

Sheet 1 of 2



LEGEND

- Engineered and Non-Engineered Fill
- Recent Sand & Silt
- Glacial Sand, Gravel, & Silt
- Glacial Clay & Silt
- Proposed Bottom of Slab
- Proposed Stacked Structure

0 60 120
Vertical Scale in Feet

0 300 600
Horizontal Scale in Feet

Vertical Exaggeration = 5X

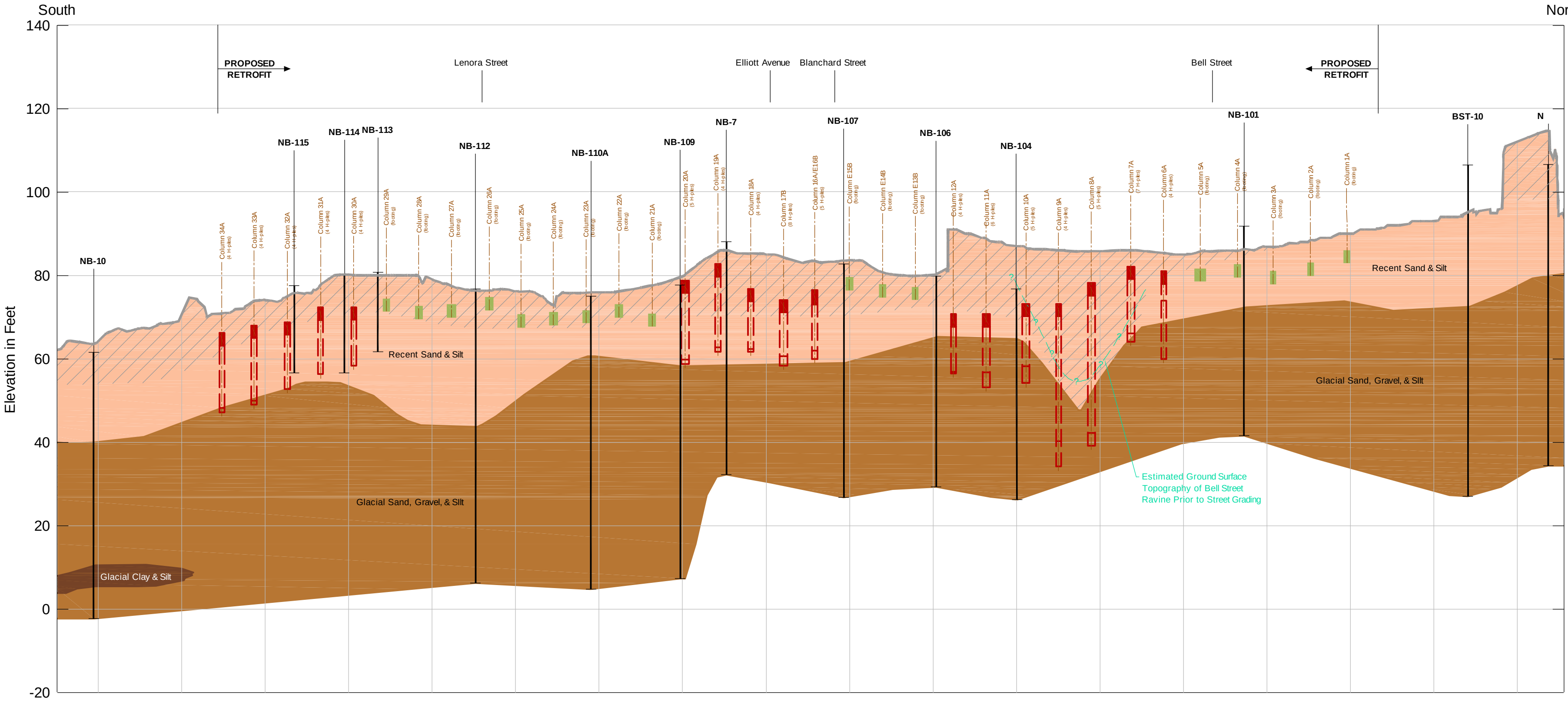
NOTES

1. This profile is based on subsurface explorations performed through December 2006 and may be modified based on future explorations and should be considered preliminary.
2. This subsurface profile is generalized from materials observed in soil borings. Variations may exist between this profile and actual conditions.
3. Existing ground surface and proposed structures are adapted from Parsons Brinckerhoff file, *"ES_Option1_060706.dwg"*, provided 6-7-06. Vertical Datum: NAVD88.

Filename: J:\211\20447-098\21-1-20501-020 Profile Cut-andCoverElevated Structure_Simplified.dwg Layout: EIS (2) Date: 12-01-2010 Login: Sandy Cottrell

GENERALIZED SUBSURFACE PROFILE ALONG THE CENTRAL CUT-AND-COVER TUNNEL AND ELEVATED STRUCTURE

Exhibit 4-2
Sheet 2 of 2



LEGEND

- Engineered and Non-Engineered Fill
- Recent Sand & Silt
- Glacial Sand, Gravel, & Silt
- Glacial Clay & Silt

0 40 80

Vertical Scale in Feet

0 200 400

Horizontal Scale in Feet

Vertical Exaggeration = 5X

NOTES

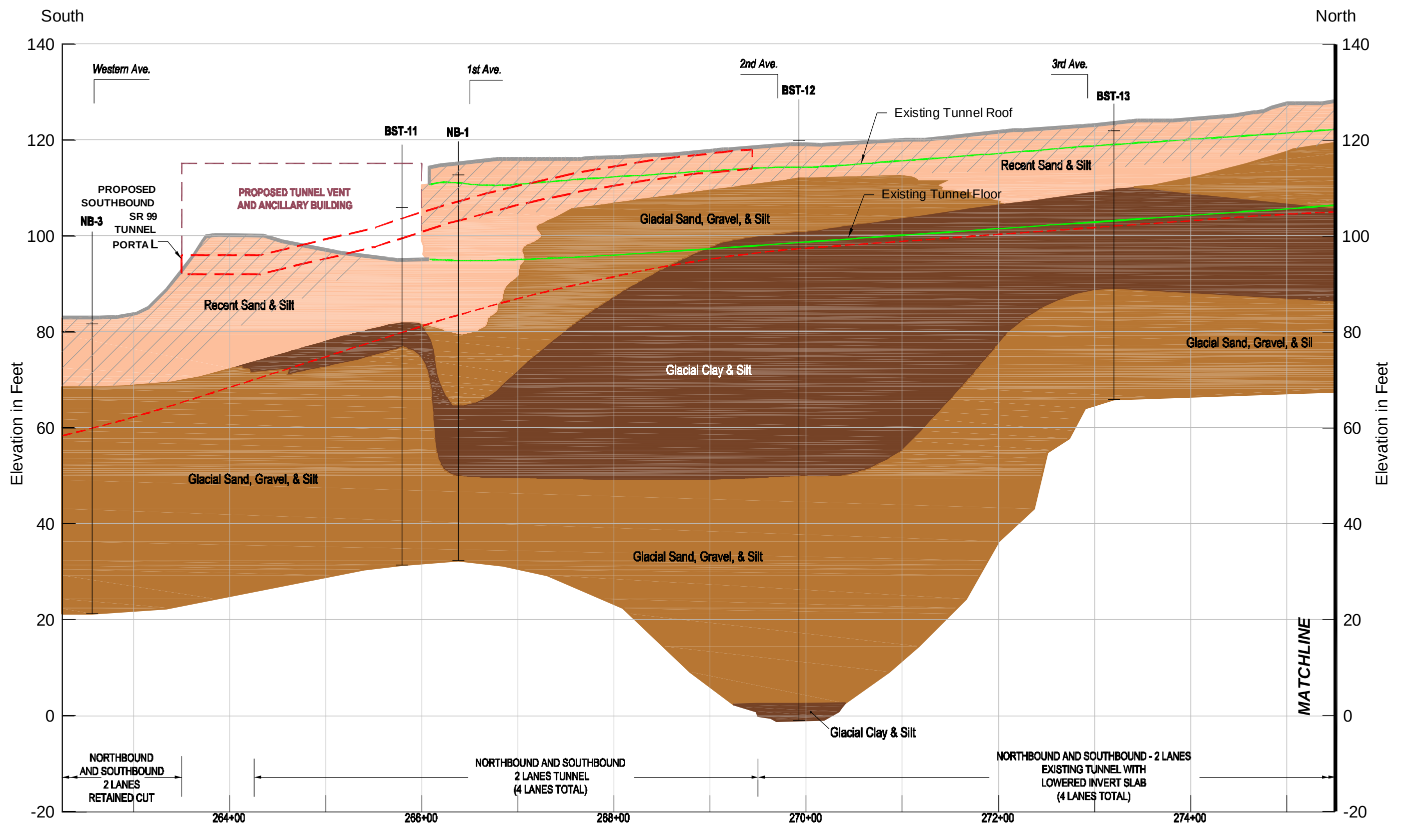
1. This subsurface profile is generalized from materials observed in soil borings. Variations may exist between this profile and actual conditions.
2. Vertical Datum: NAVD88.
3. Footing and H-pile depths were estimated based on as-built plans and pile driving records. Horizontal dimensions are approximate.
4. Columns 18E and 19E are projected greater than 10 feet to the profile.

Filename: J:\211\20447-098\21-1-20501-060 Profile-East Side Lenora to BST (Ex N Viaduct)_Simplified.dwg Layout: EIS 5X (Letter) Date: 12-01-2010 Login: Sandy Cottrell

GENERALIZED SUBSURFACE PROFILE ALONG THE EXISTING NORTH VIADUCT

Exhibit 4-3

Sheet 1 of 1



LEGEND

- Engineered and Non-Engineered Fill
- Recent Sand & Silt
- Glacial Sand, Gravel, & Silt
- Glacial Clay & Silt
- Southbound SR 99 Proposed Grade Line
- Proposed Tunnel Roof Slab

0 40 80
Vertical Scale in Feet

0 200 400
Horizontal Scale in Feet

Vertical Exaggeration = 5X

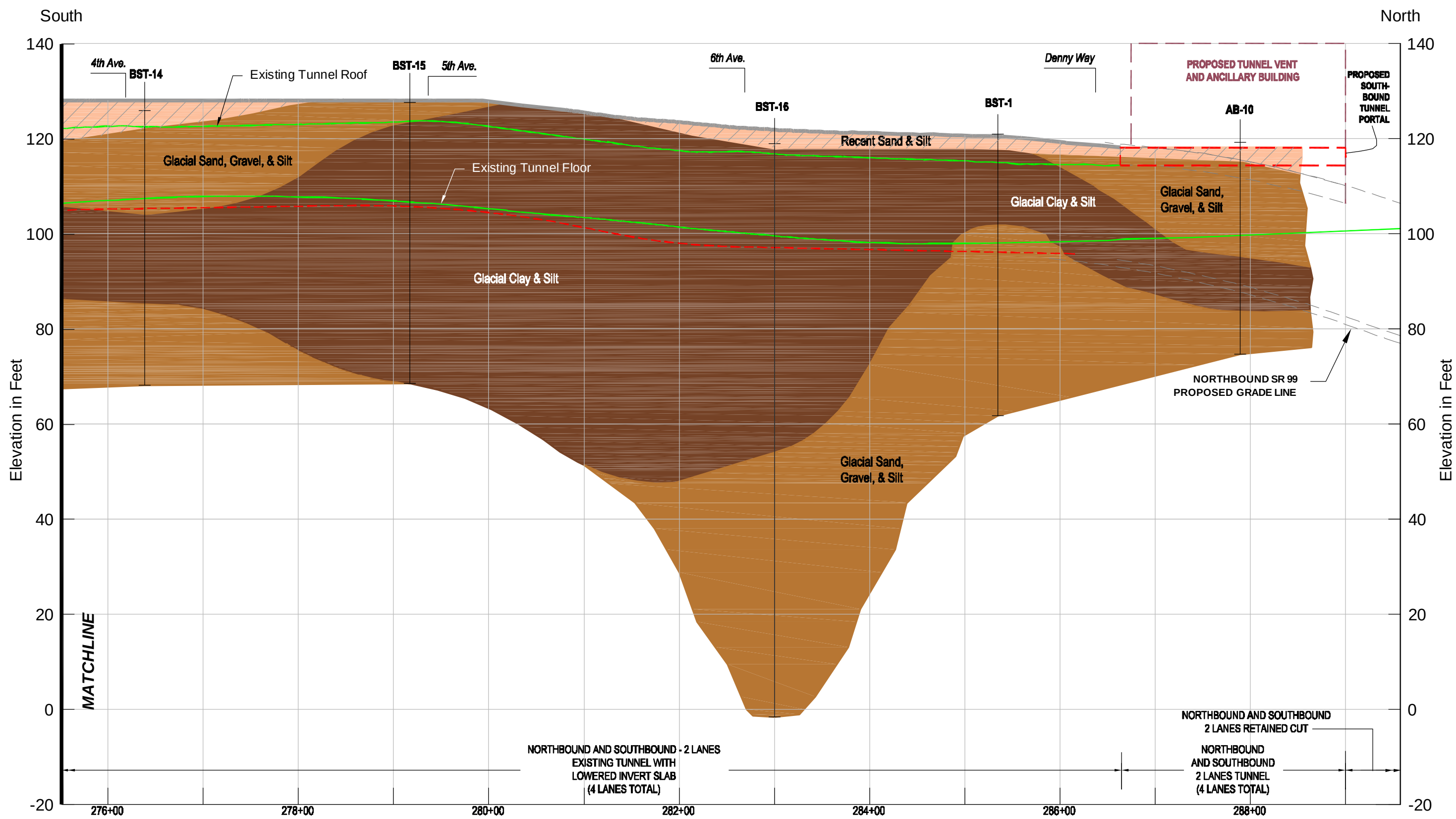
NOTES

1. This subsurface profile is generalized from materials observed in soil borings. Variations may exist between this profile and actual conditions.
2. Project alignment and grades were adapted from Microstation files *T_ALN_0606.mst* and *T_PROF_0606.mst*, provided by Parsons Brinckerhoff, received 6-30-06. Section structures taken from T313 and T315, dated 6-2-06.

Filename: J:\211\20447-098\21-1-20501-012 Profile Battery St Tunnel_Simplified.dwg Layout: EIS (1) Date: 11-16-2010 Login: Sandy Cottrell

GENERALIZED SUBSURFACE PROFILE ALONG THE BATTERY STREET TUNNEL

Exhibit 4-4
Sheet 1 of 2



LEGEND

- Engineered and Non-Engineered Fill
- Recent Sand & Silt
- Glacial Sand, Gravel, & Silt
- Glacial Clay & Silt
- Southbound SR 99 Proposed Grade Line
- Proposed Tunnel Roof Slab

0 40 80
Vertical Scale in Feet

0 200 400
Horizontal Scale in Feet

Vertical Exaggeration = 5X

NOTES

1. This subsurface profile is generalized from materials observed in soil borings. Variations may exist between this profile and actual conditions.
2. Project alignment and grades were adapted from Microstation files *T_ALN_0606.mst* and *T_PROF_0606.mst*, provided by Parsons Brinckerhoff, received 6-30-06. Section structures taken from T313 and T315, dated 6-2-06.

Filename: J:\211\20447-098\21-1-20501-012 Profile Battery St Tunnel_Simplified.dwg Layout: EIS (2) Date: 11-16-2010 Login: Sandy Cottrell

GENERALIZED SUBSURFACE PROFILE ALONG THE BATTERY STREET TUNNEL

Exhibit 4-4
Sheet 2 of 2

reaching thicknesses of up to 70 feet. The lowermost soils along the tunnel alignment consist of very dense, sandy gravel to gravelly sand.

4.1.3 North Area

Bored Tunnel Alternative

At the north portal of the bored tunnel, near the intersection of Sixth Avenue N. and Thomas Street, the double-level roadway would exit the tunnel and extend north in a cut-and-cover tunnel for the first 450 feet as it unbraids and becomes shallower. At the north end of the cut-and-cover tunnel, the north- and southbound roadways would be side by side and about 35 and 20 feet bgs, respectively. They would continue in a retained cut and reach grade near Broad Street. Broad Street would be filled in as part of the Bored Tunnel Alternative. Along the cut-and-cover section in the north area, the retained excavation would be filled in after the roadway structure is constructed The retained cuts and cut-and-cover sections of the roadway and ramps would likely be supported by soldier pile and lagging walls and/or diaphragm walls, such as secant pile walls. The north area also would include a tunnel operations building located east of Sixth Avenue N. between Thomas Street and Harrison Street, on the west half of the block. Portions of the building would extend underground to match the tunnel grade in this area (as much as about 80 feet bgs).

The surface streets above the SR 99 roadway would be connected at John, Thomas, and Harrison Streets. The retained cut roadway along Mercer Street from Fifth Avenue N. to Dexter Avenue N. would be widened from four lanes to six lanes, requiring the construction of new retaining walls for the widened roadway. Retaining walls would not be required along the south side of Mercer Street from about Fifth Avenue N. to SR 99 and along the west side of Sixth Avenue N. between Mercer Street and Harrison Street because of a future planned development by the Gates Foundation that would lower the grade south of Mercer Street. A curved Sixth Avenue N. would connect Mercer and Harrison Streets. The new roadway would have a signalized intersection at Republican Street.

The Broad Street retained cut roadway would be vacated and filled in from Taylor Avenue N. to about Ninth Avenue N. Other fills would also be placed within the cut-and-cover sections above the finished roadway structures to restore the surface grade.

Cut-and-Cover Tunnel and Elevated Structure Alternatives

The Cut-and-Cover Tunnel and Elevated Structure Alternatives include lowering the SR 99 roadway north of the Battery Street Tunnel into a side-by-side retained cut between the north portal and about Mercer Street. Modifications to the existing portal walls and new retaining walls would be required.

Upgrades to existing on- and off-ramps would be constructed at Denny Way and Roy Street. The existing Broad Street would be filled between Fifth and Ninth Avenues N. to reconnect the local street grid. New bridges would be constructed at Thomas and Harrison Streets. Mercer Street would be widened and continue to cross under SR 99 as it does today. A tunnel maintenance building for the cut-and-cover tunnel would be constructed adjacent to the west side of SR 99, near Denny Way.

Subsurface Conditions

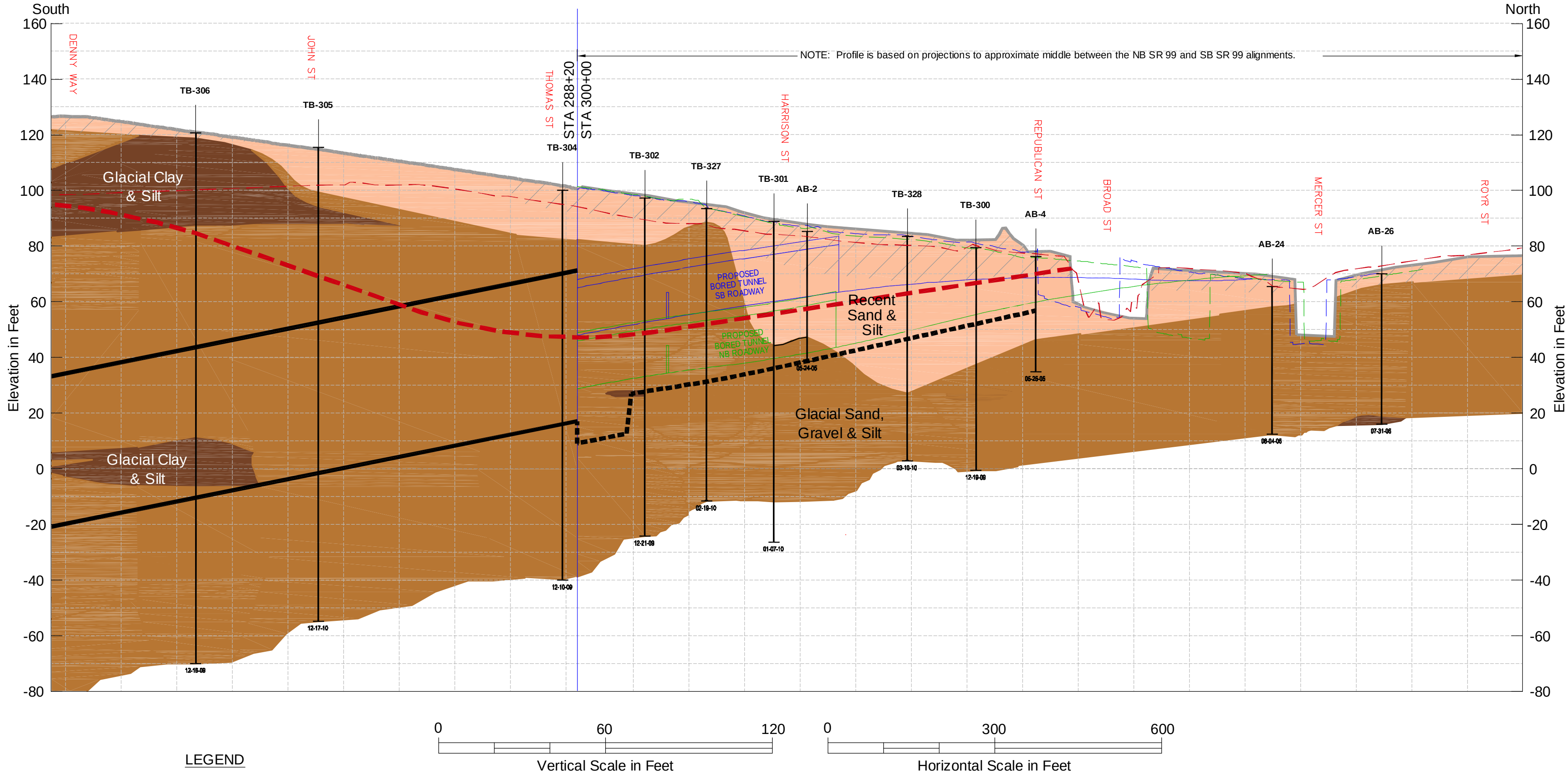
The north area is underlain by interlayered fine-grained and coarse-grained soils. Silt, sand, and clay with varying amounts of gravel extend to depths of 15 to 40 feet bgs. In contrast to fill in the south area, fill in the north area contains little debris and consists primarily of native material placed during the Denny Regrade project, as discussed in *Interim Letter CT-6, Geologic Characterization Report (GCR) – Central Waterfront Tunnel* (Shannon & Wilson 2010c). These soils are underlain by very dense sand and gravel, with increasing silt content north of the north portal of the bored tunnel. A profile of subsurface conditions and the proposed excavation is shown in Exhibit 4-5.

For the Cut-and-Cover Tunnel and Elevated Structure Alternatives, the existing roadway would be widened to a side-by-side retained cut, with most of the excavation occurring on the west side of the existing SR 99 roadway. Subsurface conditions are similar to those encountered along the bored tunnel alignment, which is approximately 200 feet west of SR 99. The proposed excavation for SR 99 is shown on the profile in Exhibit 4-5.

The depth to groundwater is a function of the ground surface elevation and the presence of occasional perched water-bearing zones. Between and beneath the perched water-bearing zones that typically exist in the upper 20 feet of soil, the fine-grained soils may be unsaturated down to the underlying water table aquifer. Near the north end of the project area, the regional water table is between 70 and 80 feet bgs, as the ground surface dips down toward Lake Union.

4.2 Field Data

Soil and groundwater samples have been collected from explorations and monitoring wells completed as part of the Program. Soil and groundwater samples were analyzed for potential contaminants that could affect handling and disposal of soil and groundwater. Explorations with environmental sample results completed between 2002 and April 2010 within 200 feet of the build alternative alignments are shown in Exhibit 4-6.



LEGEND

- Engineered and Non-Engineered Fill
- Recent Sand & Silt
- Glacial Sand, Gravel, & Silt
- Glacial Clay & Silt
- Proposed Bored Tunnel Southbound Roadway
- Proposed Bored Tunnel Northbound Roadway
- Limits of Proposed Bored Tunnel
- Approximate Bottom of Bored Tunnel Excavation
- Approximate Bottom of Slab for Cut-and-Cover Tunnel Alternative
- Approximate Ground Surface for Cut-and-Cover Tunnel Alternative

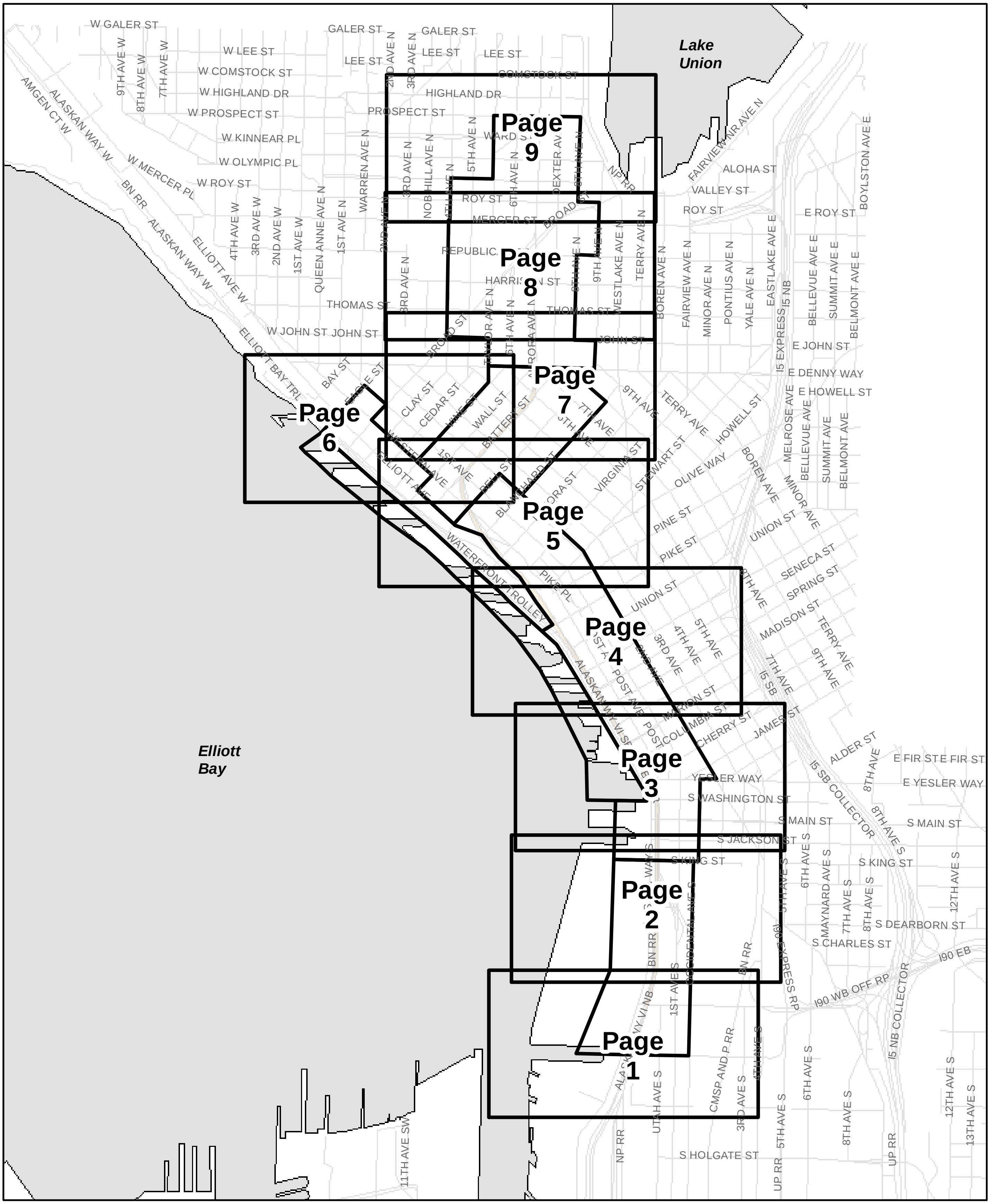
NOTES

1. Existing grade adapted from City of Seattle GIS data files *"topo_all.dwg"* received 3-11-02. Proposed structure based on *"North Portal-Geo_XSection _SH.dgn"* provided by Parsons Brinckerhoff 6-3-10. Cut and cover bottom of slab is taken from *"AWV Cut & Cover Tunnel Plans_SDIS Update Aug 2010.pdf"* and projected eastward approximately from 30 to 100 feet onto the bored tunnel alignment.
2. This profile is based on subsurface explorations performed through September 2010. Variations may exist between this profile and actual conditions.
3. Proposed roadway structures shown are approximate.
4. Vertical Datum: NAVD88.

Filename: J:\211\20447-098\21-1-21400-025 Bored Tunnel Profile_Simplified.dwg Layout: EIS North Area Date: 12-01-2010 Login: sac

GENERALIZED SUBSURFACE PROFILE ALONG NORTH AREA

Exhibit 4-5
Sheet 1 of 1



T:\Project\21-1\20447_AWV_PH1\AV_mxd\2010\Borings2007_Index.mxd 10/26/2010 (ATJ)

N

0 1,000 2,000 4,000
Feet

INDEX FOR BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

LEGEND

Exploration Alternative Locations

Cut-and-Cover Tunnel and Elevated Structure Alternatives

Bored Tunnel Alternative

All Alternatives

NOTE: Borings are within approximately 200 feet of alignments.

Study Areas

Cut-and-Cover Tunnel
and Elevated Structure Alternatives

Bored Tunnel Alternative

Proposed Alignments

Elevated Structure Alignment

Cut-and-Cover Tunnel Alignment

Bored Tunnel Alignment

Surface Streets

To Be Decommissioned

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LEGEND FOR BORINGS WITH ENVIRONMENTAL TEST RESULTS

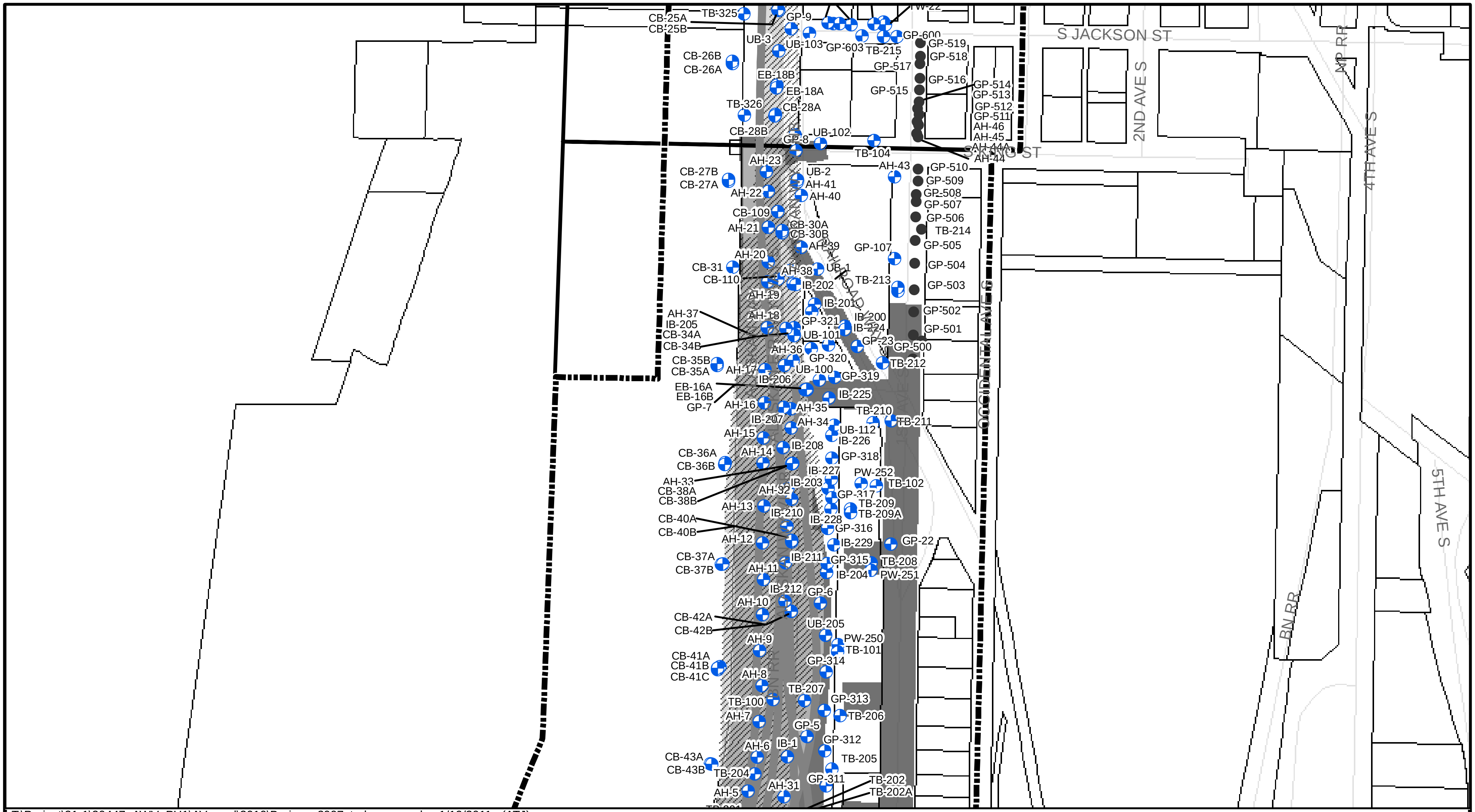
Exhibit 4-6

T:\Project\21-1\20447_AWV_PH1\AV_mxd\2010\Borings_2007studyarea.mxd 1/19/2011 (ATJ)

BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 1 of 9



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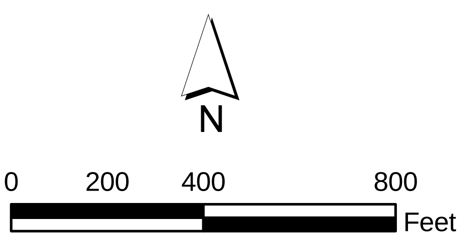
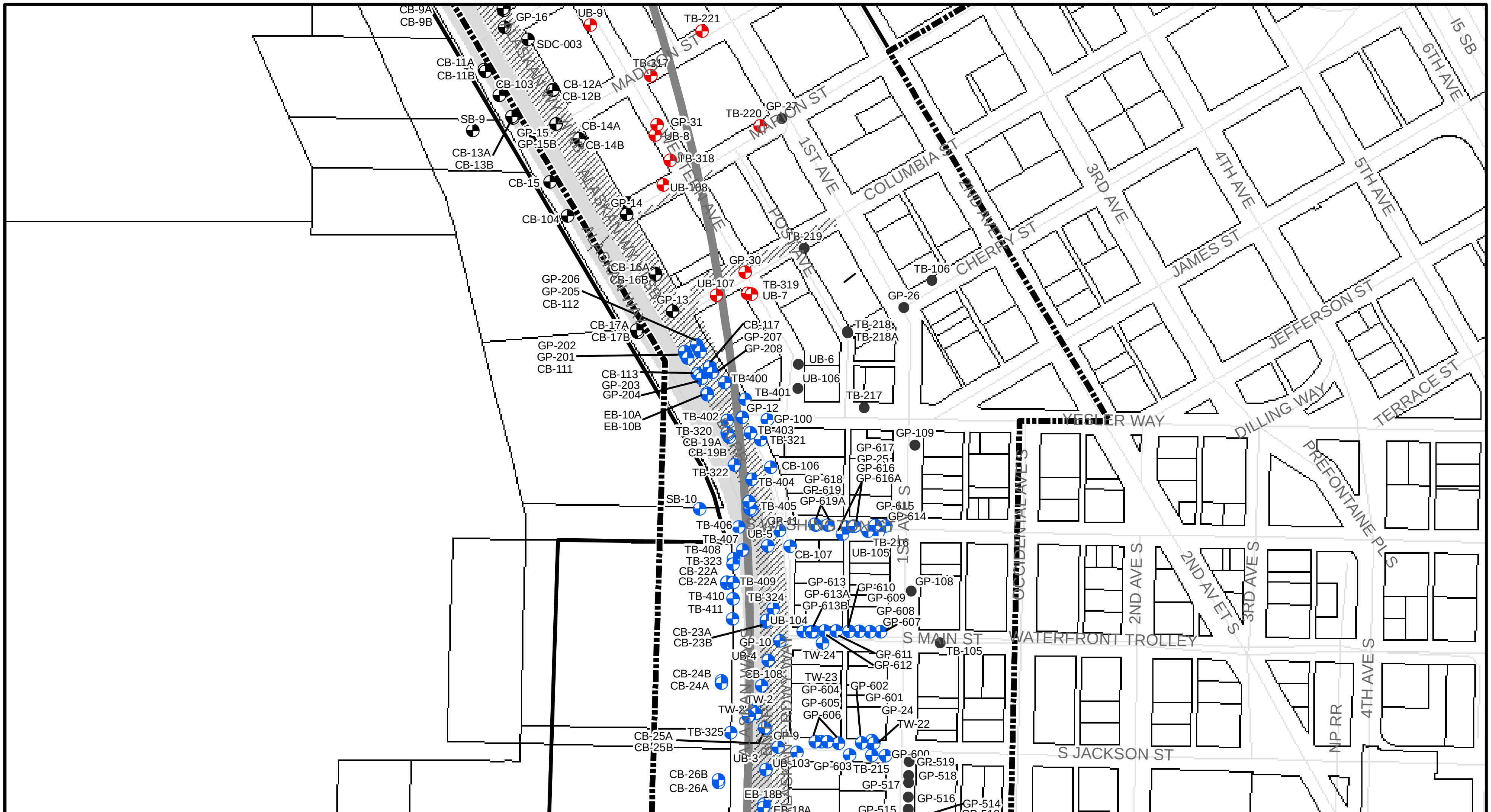


BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 2 of 9



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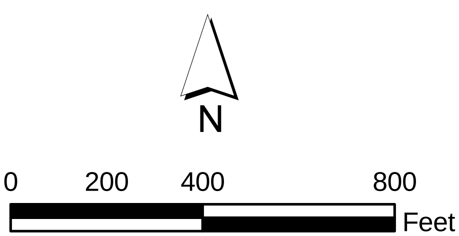
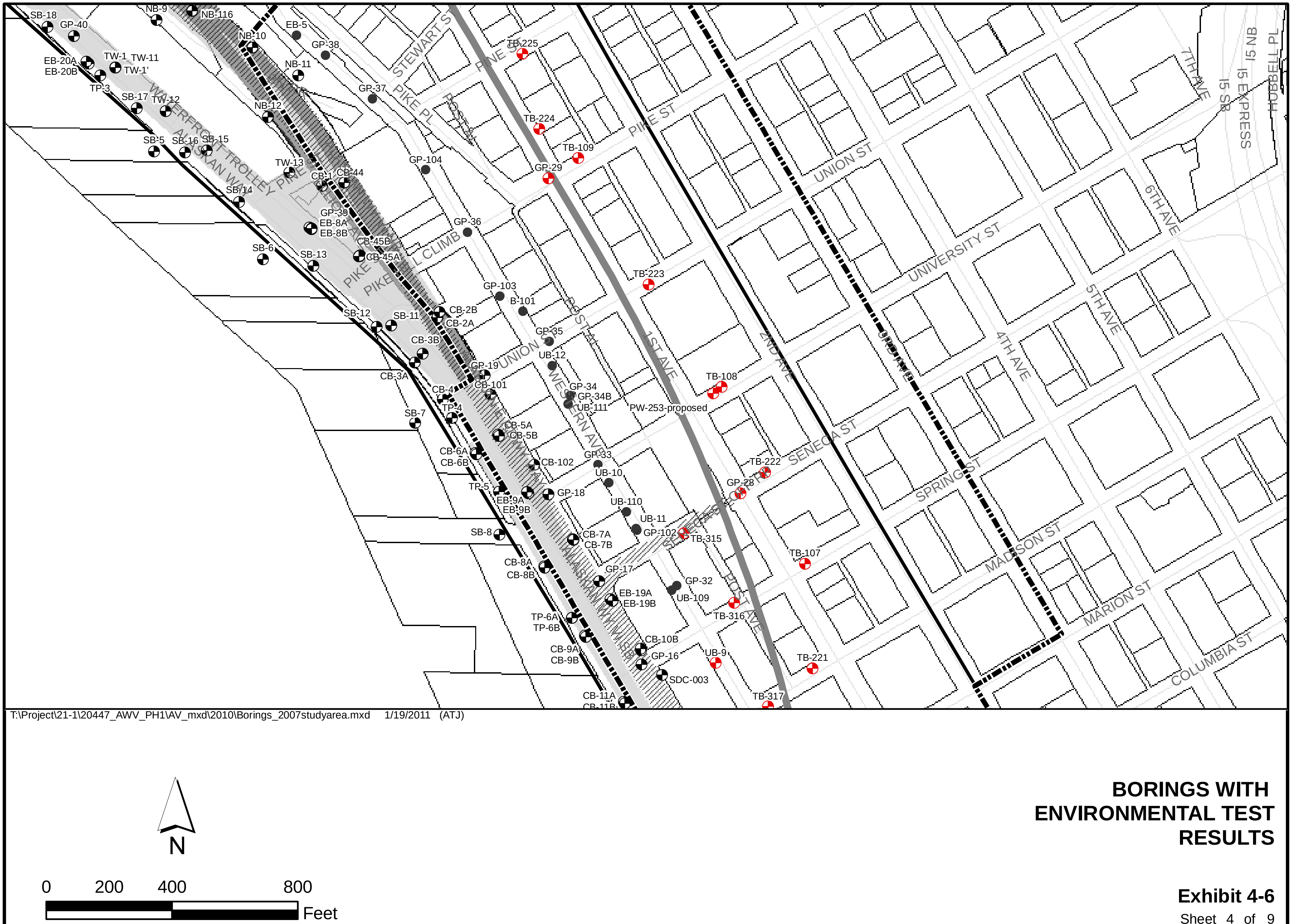


BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 3 of 9

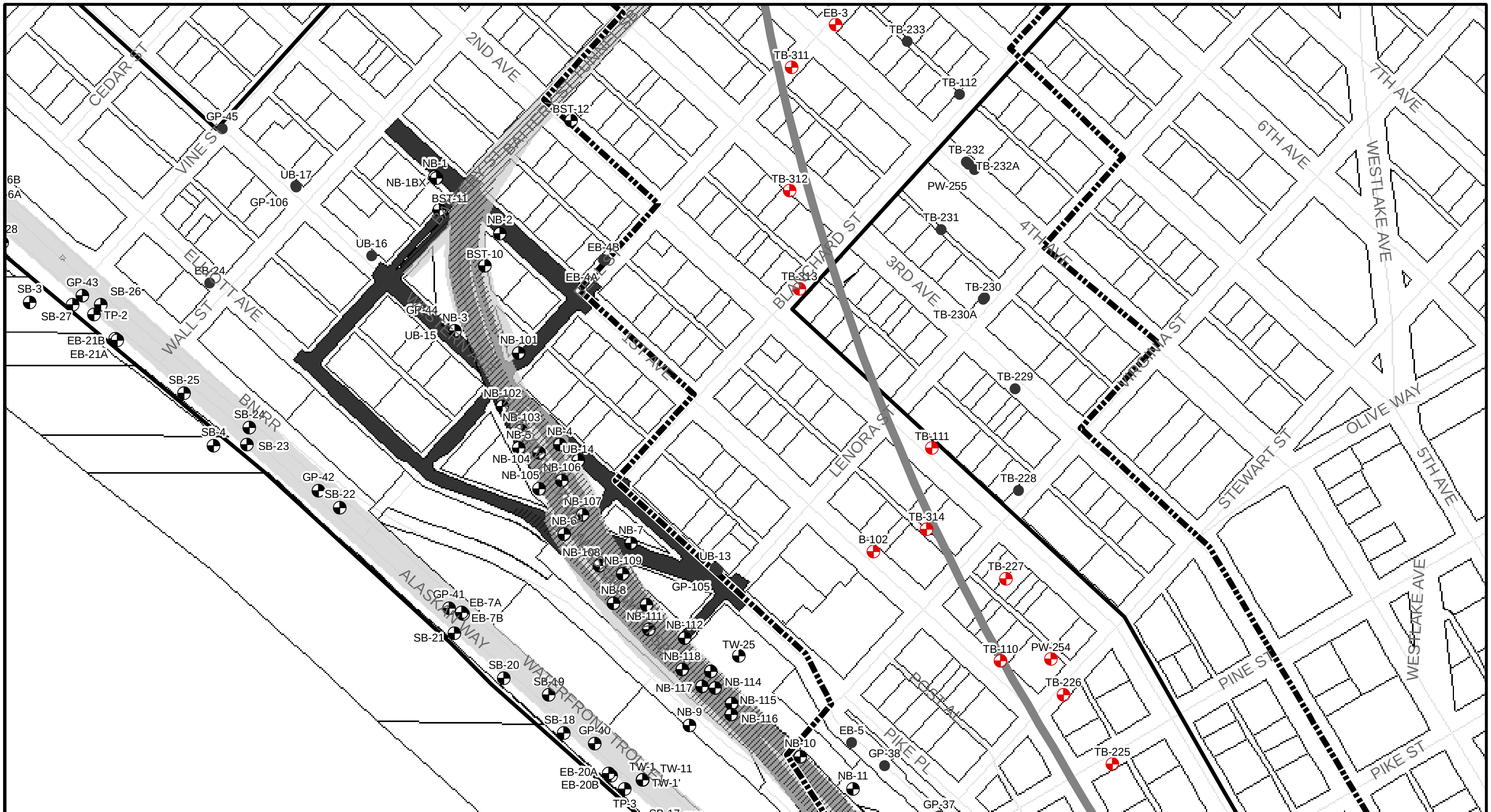


T:\Project\21-1\20447_AWV_PH1\AV_mxd\2010\Borings_2007studyarea.mxd 1/19/2011 (ATJ)

BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 4 of 9



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N

0 200 400 800
Feet

BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 5 of 9

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N

0 200 400 800 Feet

BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 6 of 9

T:\Project\21-1\20447_AWV_PH1\AV_mxd\2010\Borings_2007studyarea.mxd 1/19/2011 (ATJ)

N

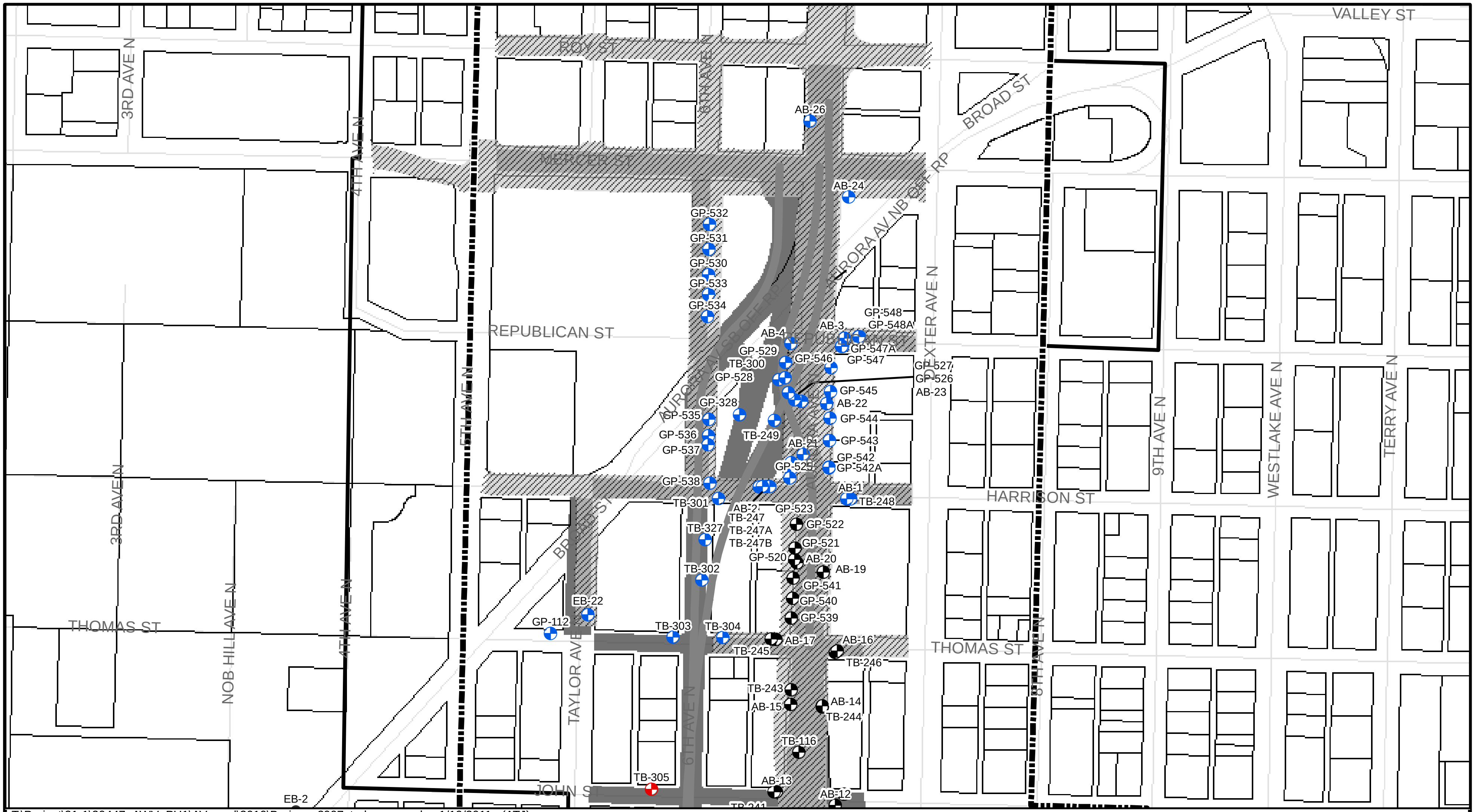
0 200 400 800

Feet

BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 7 of 9



T:\Project\21-1\20447_AWV_PH1\AV_mxd\2010\Borings_2007studyarea.mxd 1/19/2011 (ATJ)

N

0 200 400 800
Feet

BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 8 of 9

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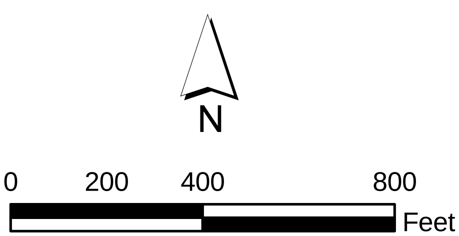


BORINGS WITH ENVIRONMENTAL TEST RESULTS

Exhibit 4-6

Sheet 9 of 9

Sampling points located within 200 feet of the proposed alignments provide data for a screening-level evaluation of soil and groundwater quality. Exhibits F-3 and F-4 in Attachment F show the sampling locations and analytical results for organic compounds that have been detected in soil and groundwater samples collected for the Program. Results for pH are provided in Attachment F, Exhibit F-5.

The analytical data for fill material and native soil are discussed separately because the environmental characteristics of these materials tend to differ significantly in some areas. Fill material includes soil that was placed by humans, either in an engineered or non-engineered fashion. Native soils include recent deposits (e.g., alluvium, estuarine, and beach deposits) and older glacially overridden soils. A more detailed description of the soil types encountered along the build alternative alignments is included in *Interim Letter CT-6, Geologic Characterization Report (GCR) – Central Waterfront Tunnel* (Shannon & Wilson 2010c).

The distribution and concentrations of potential contaminants for the Bored Tunnel Alternative are provided by station in the *CT-15 Environmental Considerations Report (*for the Bored Tunnel Alternative) (Shannon & Wilson 2010a). Potential contaminants for the Cut-and-Cover Tunnel and Elevated Structure Alternatives are indicated in the *Alaskan Way Viaduct and Seawall Replacement Project Environmental Considerations Report* (Shannon & Wilson 2005b). The samples were analyzed for both organic and inorganic analytes. Because metals were encountered at background levels in most of the samples, the metals results were evaluated, but they have not been compiled for this report. The complete results are provided in the reports listed in Section 3.8. The analytical results for the detected compounds are summarized in Sections 4.2.1 and 4.2.2.

4.2.1 Soil

The soil samples were analyzed for a broad suite of chemicals of potential concern. Of the 26 analytes for which MTCA Method A cleanup levels have been established for unrestricted land use, 10 were detected in the soil samples. Of a total of 1,400 soil samples analyzed for potential contaminants, 7 percent had concentrations that exceeded the MTCA Method A cleanup levels. The MTCA Method A unrestricted land use category of cleanup levels was used for the evaluation because of the mixed land use along the build alternative alignments; it uses conservative assumptions based on residential exposure scenarios. The north area consists primarily of commercial properties, including hotels. In addition, some land reclamation facilities use MTCA Method A criteria as the basis of their acceptance criteria. The sampling locations and the types and concentrations of contaminants in native soil exceeding the MTCA Method A cleanup levels are indicated in Exhibit 4-7. MTCA exceedances in fill soils are indicated in Exhibit 4-8.

Exhibit 4-7. Native Soil Samples With Contaminant Concentrations Exceeding MTCA Method A Cleanup Levels

Area	Boring Designation	Depth (feet bgs)	Analyte and Method						
			Arsenic EPA Method 6010 (mg/kg)	Lead EPA Method 6010 (mg/kg)	Oil-Range Petroleum Hydrocarbons[1] NWTPH-Dx (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Tetrachloroethylene EPA Method 8260 (mg/kg)	Trichloroethylene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted) EPA Method 8270C – SIM (mg/kg)
MTCA Method A cleanup levels			20	250	2,000	0.03	0.05	0.03	0.1
All Build Alternatives									
South	IB-236	30	31						
Central	CB-15	53							1.3
Central	CB-9B	60							4.8
Central	EB-10A	26							0.15
Bored Tunnel Alternative Only									
Central	EB-18A	20							3.304
Central	TB-226	189.5	47						
Cut-and-Cover Tunnel and Elevated Structure Alternatives Only									
Central	GP-504	11				0.06			
Battery Street Tunnel	TB-235	116	100						
North waterfront	EB-20A	20			2,900				
North waterfront	EB-20A	20							6.431
North waterfront	EB-21A	25	21						
North waterfront	EB-21A	25							1.271
North	AB-12	13	120						

Exhibit 4-7. Native Soil Samples With Concentrations Exceeding MTCA Method A Cleanup Levels (continued)

Area	Boring Designation	Depth (feet bgs)	Analyte and Method						
			Arsenic EPA Method 6010 (mg/kg)	Lead EPA Method 6010 (mg/kg)	Oil-Range Petroleum Hydrocarbons[1] NWTPH-Dx (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Tetrachloroethylene EPA Method 8260 (mg/kg)	Trichloroethylene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted) EPA Method 8270C – SIM (mg/kg)
MTCA Method A cleanup levels			20	250	2,000	0.03	0.05	0.03	0.1
North	AB-16	23		600					
North	GP-522	22					0.22	0.03	
North	GP-522	25						0.07	
North	TB-241	30	21						
North	TB-248	20				0.38			
No. of detections exceeding MTCA cleanup level ÷ no. of samples in native soil tested for analyte			<1%	<1%	<1%	<1%	<1%	<1%	<1%

Note: A blank cell indicates that either no test for the analyte was performed, or the concentration was less than the MTCA Method A cleanup level.
bgs = below ground surface
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NWTPH-Dx = Northwest total petroleum hydrocarbon–diesel-extended
SIM = selective ion method (necessary for lower detection limit)
TEF = toxicity equivalency factor
[1] Oil-range petroleum hydrocarbons include lubricating oil and heavy-oil-range hydrocarbons.

Exhibit 4-8. Soil Samples From Fill With Contaminant Concentrations Exceeding MTCA Method A Cleanup Levels

Area	Boring Designation	Depth (feet bgs)	Analyte and Method: Arsenic EPA Method 6010 (mg/kg)	Lead/TCLP-Lead [1,2] EPA Method 6010/ (mg/kg/(mg/L)	Cadmium/Mercury EPA Method 6010B/EPA Method 7471 (mg/kg)	Oil-Range Petroleum Hydrocarbons NWTPH-Dx (mg/kg)	Gasoline NWTPH-Gx[3] (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted)/ Naphthalene[4] EPA Method 8270C-SIM (mg/kg)
MTCA Method A cleanup levels			20	250/5	2/2	2,000	100/30	0.03	0.1/5
All Build Alternatives									
South	CB-36A	10		760/0.2					
South	CB-37A	8		290/0.2					
South	CB-37A	15	27	280/NT[5]					
South	CB-43A	2		250/0.21					
South	EB-15A	19	22						
South	GP-309	7							1.64
South	GP-311	10		350/0.52					
South	GP-314	10	37	440/0.2					0.56
South	GP-408	3.5							5.52
South	IB-1	2	29						
South	IB-215	8	25						0.46
South	IB-215	10	20						
South	IB-216	2							0.18
South	IB-221	2					10 U	0.04	
South	IB-221	10					32	0.07	
South	IB-222	9							0.13
South	IB-223	5							0.21
South	IB-232	10							
South	IB-234	15							0.12

Exhibit 4-8. Soil Samples From Fill With Concentrations Exceeding MTCA Method A Cleanup Levels (continued)

Area	Boring Designation	Depth (feet bgs)	Analyte and Method						
			Arsenic EPA Method 6010 (mg/kg)	Lead/TCLP-Lead [1,2] EPA Method 6010/ (mg/kg/(mg/L)	Cadmium/Mercury EPA Method 6010B/EPA Method 7471 (mg/kg)	Oil-Range Petroleum Hydrocarbons NWTPH-Dx (mg/kg)	Gasoline NWTPH-Gx[3] (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted)/ Naphthalene[4] EPA Method 8270C-SIM (mg/kg)
MTCA Method A cleanup levels			20	250/5	2/2	2,000	100/30	0.03	0.1/5
South	IB-236	3							0.53
South	IB-238	5		440/0.09					0.76
South	IB-238	5					NT	0.03	0.42
South	IB-238	20							0.10
South	IB-242	2							0.22
South	TB-101	1		290/0.5 U					0.29
South	TB-203	6		260/3.8					
South	TB-211	5					10 U	1.5	
Central	AH-22	19			Cadmium 2.2				0.87
Central	AH-23	17							14.30
Central	CB-2A	15		310/0.64					
Central	CB-5A	18				6,600			
Central	CB-8A	30							0.52
Central	CB-8A	30.5							0.16
Central	CB-8A	45			Mercury 5.2				
Central	CB-8B	47.5							0.66
Central	CB-9A	28		250/0.2					
Central	CB-9B	30							2.65/120
Central	CB-9B	60							2.65/79
Central	CB-13A	45		270/0.49					2.52/160
Central	CB-15	43			Mercury 7.1				0.49/210

Exhibit 4-8. Soil Samples From Fill With Concentrations Exceeding MTCA Method A Cleanup Levels (continued)

Area	Boring Designation	Depth (feet bgs)	Arsenic EPA Method 6010 (mg/kg)	Lead/TCLP-Lead [1,2] EPA Method 6010/ (mg/kg/(mg/L)	Cadmium/Mercury EPA Method 6010B/EPA Method 7471 (mg/kg)	Oil-Range Petroleum Hydrocarbons NWTPH-Dx (mg/kg)	Gasoline NWTPH-Gx[3] (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted)/ Naphthalene[4] EPA Method 8270C-SIM (mg/kg)
			Analyte and Method						
MTCA Method A cleanup levels			20	250/5	2/2	2,000	100/30	0.03	0.1/5
Central	CB-15	53							1.27/50
Central	CB-17A	40							3.25
Central	CB-31	3		1000/0.38					
Central	EB-9A	10		360/0.31	Mercury 3.6				
Central	EB-9A	13		290/NT[5]					
Central	EB-10A	6							0.25
Central	EB-10A	9			Cadmium 3.8				
Central	EB-19A	25							
Central	GP-16	15							0.59
Central	GP-24	2				16,000			
Central	GP-321	6		820/1.1		2,800			0.99
Central	GP-610	4		290/0.5 U					0.42
Central	TB-104	7							0.34
Central	TB-213	7					10 U	0.06	
Central	TB-216	7							18.19
Bored Tunnel Alternative Only									
Central	CB-21A	20		250/0.36					
Central	CB-108	3				2,300			
Central	GP-201	5.5							0.21
Central	GP-205	6							0.28
Central	TB-325	2.7							1.55

Exhibit 4-8. Soil Samples From Fill With Concentrations Exceeding MTCA Method A Cleanup Levels (continued)

Area	Boring Designation	Depth (feet bgs)	Analyte and Method						
			Arsenic EPA Method 6010 (mg/kg)	Lead/TCLP-Lead [1,2] EPA Method 6010/ (mg/kg/(mg/L)	Cadmium/Mercury EPA Method 6010B/EPA Method 7471 (mg/kg)	Oil-Range Petroleum Hydrocarbons NWTPH-Dx (mg/kg)	Gasoline NWTPH-Gx[3] (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted)/ Naphthalene[4] EPA Method 8270C-SIM (mg/kg)
MTCA Method A cleanup levels			20	250/5	2/2	2,000	100/30	0.03	0.1/5
Central	TB-325	9.5		280/0.5 U					0.14
Central	TB-326	22.3							0.33
Central	TB-403	11		3,300/0.5 U					
Central	TB-405	17							0.38
Central	TB-406	23		330 /0.5 U					0.38
Central	TB-411	12		780/0.62					0.36
Central	UB-3	19			Mercury 2.3				2.11
Central	UB-9	23		4,400/**10**					
Central	UB-103	9	21				130	0.019[6]	
Central	UB-107	11		720/**8.6**					
Cut-and-Cover Tunnel and Elevated Structure Alternatives Only									
Central	GP-13	6				2,500			
Central	GP-502	6							1.33
Central	TB-103	3							2.78
Central	TB-106	2.1							0.21
Central	UB-109	10							0.34
Central	UB-111	7.5							0.56
North	AB-14	7				2,300			
North waterfront	EB-7A	8	22						
North waterfront	EB-8A	10					510	0.06 U	
North waterfront	GP-40	13							0.67

Exhibit 4-8. Soil Samples From Fill With Concentrations Exceeding MTCA Method A Cleanup Levels (continued)

Area	Boring Designation	Depth (feet bgs)	Analyte and Method						
			Arsenic EPA Method 6010 (mg/kg)	Lead/TCLP-Lead [1,2] EPA Method 6010/ (mg/kg/(mg/L)	Cadmium/Mercury EPA Method 6010B/EPA Method 7471 (mg/kg)	Oil-Range Petroleum Hydrocarbons NWTPH-Dx (mg/kg)	Gasoline NWTPH-Gx[3] (mg/kg)	Benzene EPA Method 8260 (mg/kg)	Total cPAHs (TEF Adjusted)/ Naphthalene[4] EPA Method 8270C-SIM (mg/kg)
MTCA Method A cleanup levels			20	250/5	2/2	2,000	100/30	0.03	0.1/5
Percentage of samples exceeding MTCA cleanup level[6]			1%	3%/2%	<1%	<1%	2%	<1%	22%/<1%

Notes: A blank cell indicates that either no test for the analyte was performed, or the concentration was less than the MTCA Method A cleanup level.

A **bold** number means the value exceeds the dangerous waste criteria, not the MTCA Method A cleanup level.

bgs = below ground surface
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
EPA = U.S. Environmental Protection Agency
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NT = not tested
NWTPH-Dx = Northwest total petroleum hydrocarbon–diesel-extended
NWTPH-G = Northwest total petroleum hydrocarbon–gasoline-range
SIM = selective ion method (necessary for lower detection limit)
TCLP = Toxicity Characteristic Leaching Procedure
TEF = toxicity equivalency factor
U = not detected at the laboratory reporting limit

[1] TCLP results are compared with the dangerous waste criteria (WAC Chapter 173-303). For lead the value is 5 mg/L.
[2] Only the highest lead concentration in a boring was analyzed by TCLP for disposal characterization. All investigation-derived waste soil was combined in one drum.
[3] The cleanup level for gasoline-range petroleum hydrocarbons is 100 mg/kg when benzene is not present and 30 mg/kg when benzene is present.
[4] Naphthalene was analyzed by EPA Method 8260 for volatile organic compounds and EPA Method 8270C for semivolatile organic compounds. Naphthalene results for either method are reported.
[5] This result was not the highest value in the boring. Another sample from the same boring was tested by TCLP.
[6] Benzene was reported in this table even though the concentration was below the MTCA criterion because the presence or absence of benzene is a factor in determining the appropriate cleanup level.
[7] Percentage was determined by dividing the number of samples that exceed the MTCA cleanup level by the number of samples tested for that analyte in fill.

Less than 1 percent of the samples collected from native soil had concentrations that exceeded the MTCA Method A cleanup levels. Arsenic was detected in six samples at concentrations greater than the MTCA cleanup level of 20 mg/kg. An elevated concentration of lead was detected in one sample, at 600 mg/kg, in the north area. Lubricating oil was detected in one sample collected along the north waterfront, at a concentration greater than the MTCA cleanup level of 2,000 mg/kg. Benzene was encountered at two locations along the waterfront, at depths of 10.5 feet and 20 feet bgs. Chlorinated solvents (tetrachloroethylene and trichloroethylene) were detected at depths of 22 and 25 feet in probes drilled along Aurora Avenue N. The probes were drilled adjacent to the Vagabond Inn site (currently Seattle Pacific Hotel), a former dry-cleaning operation with documented soil and groundwater contamination. Elevated concentrations of cPAHs (adjusted for toxicity equivalency factor) were detected in native soil at a few locations along the waterfront. Localized cPAH contamination in native soil is likely associated with creosote-treated timbers.

Land reclamation facilities have established 8.5 as the pH acceptance criterion. Native soil with pH levels above 8.5 was encountered along the build alternative alignments, at depths as much as 267 feet bgs. Elevated pH results were encountered across a broad range of depths and distributed throughout the study areas. No trend was evident. Of the samples tested for pH, 32 percent exceeded 8.5.

As much as 50 feet of fill has been identified in the study areas. Metals, petroleum products, benzene, PAHs, and naphthalene have been detected at concentrations greater than the MTCA Method A cleanup levels in fill that would be removed for all three build alternatives. Arsenic, lead, cadmium, and mercury have been encountered at least once at concentrations greater than their respective MTCA cleanup levels. No concentrations of metals in excess of the MTCA Method A cleanup levels have been detected in the north area. Lead has been detected by TCLP in two fill samples at concentrations that exceeded the dangerous waste criterion of 5 milligrams per liter (mg/L). The fill samples were collected from borings UB-107 and UB-9, which were located inland from the waterfront, exclusively in the Bored Tunnel Alternative study area. Only boring UB-107 (on Columbia Street between Western Avenue and Alaskan Way S.) was located near a potential ground improvement area for the Bored Tunnel Alternative, where fill soil may be removed as part of the spoils. Boring UB-9 was located on Western Avenue between Spring Street and Madison Street. The source of the elevated concentrations of metals in the fill is unknown.

Petroleum hydrocarbons and related compounds were encountered throughout the fill soils underlying the waterfront and the south area. Lubricating oil was identified as the primary petroleum contaminant; it was likely associated with the numerous railroads that operated in the area. Less than 1 percent of the samples analyzed for petroleum had concentrations that exceeded the MTCA Method A cleanup level of 2,000 mg/kg. Isolated detections of gasoline at concentrations greater than the MTCA cleanup level of 100 mg/kg (30 mg/kg if benzene is also present) have occurred. Benzene, which is typically associated with gasoline, has also been identified at concentrations greater than the MTCA cleanup level of 0.03 mg/kg. Total cPAHs (adjusted for toxicity equivalency factor) is the contaminant that most frequently exceeded the MTCA Method A cleanup level of 0.1 mg/kg (50 samples). A soil pH greater than 8.5 has also been encountered in fill soils, without any apparent trend. The pH results are provided in Attachment F, Exhibit F-5.

4.2.2 Groundwater

Widespread groundwater contamination or contaminated groundwater plumes have not been detected in monitoring wells installed along the build alternative alignments, although isolated instances of low-level contamination have been identified. The analytical results for organic compounds with concentrations that exceeded the MTCA Method A cleanup levels are provided in Exhibit 4-9. Depending on the level of contamination, water generated during construction may require treatment before discharge to the sewer. If groundwater is reinjected, it must not degrade water quality (see Section 6.2.1).

Petroleum hydrocarbons were detected in scattered locations along the waterfront portion of the bored tunnel alignment and in the south and the north areas. Concentrations of lubricating oil and gasoline each exceeded the MTCA Method A cleanup level once.

Low concentrations of cPAHs were detected at monitoring wells that were installed in areas of long-term railroad use and/or in fill along Alaskan Way S. When adjusted for toxicity equivalency factors, one groundwater sample exceeded the MTCA Method A cleanup level of 0.1 microgram per liter (μg/L) for total cPAHs.

Scattered detections of VOCs occurred in samples from shallow groundwater in the south area, in the bored tunnel area along the waterfront, and in the north area. These detections were all less than the MTCA Method A cleanup levels, with the exception of three samples. Vinyl chloride was detected in a sample collected from monitoring well AB-4, at a concentration of 0.25 μg/L, which is slightly greater than the MTCA Method A cleanup level of 0.2 μg/L. Monitoring well AB-4 was installed at the northwest corner of Republican Street and Aurora Avenue N. in a perched groundwater zone. Benzene was detected in a sample from monitoring well EB-9B (central area) at a concentration equal to the MTCA Method A cleanup level of 5 μg/L. Tetrachloroethylene was detected in

Exhibit 4-9. Groundwater Samples With Concentrations of Organic Compounds Exceeding MTCA Method A Cleanup Levels

Area	Boring Designation	Depth (feet bgs)	Analyte and Method					
			Gasoline NWTPH-Dx (µg/L)	Oil-Range Petroleum Hydrocarbons - NWTPH-Dx[1] (µg/L)	Benzene EPA Method 8260 (µg/L)	Tetrachloroethylene EPA Method 8260 (µg/L)	Vinyl Chloride EPA Method 8260 (µg/L)	Total cPAHs EPA Method 8270C – SIM (µg/L)
MTCA Method A cleanup level			**800/1,000[2]**	500	5	5	0.2	0.1
All Build Alternatives								
Central	EB-9B	52.4			5			
Central	CB-25A	12.7						0.11
Central near south portal	CB-27A	53	2,000					
Central near south portal	CB-110A	60		1,400				
North	AB-4	6					0.25	
Elevated Structure and Cut-and-Cover Tunnel Alternatives Only								
North	AB-12	13		2,000		7.5		

Note: A blank cell indicates that either no test for the analyte was performed, or the concentration was less than the MTCA Method A cleanup level.
bgs = below ground surface
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
EPA = U.S. Environmental Protection Agency
µg/L = micrograms per liter
MTCA = Model Toxics Control Act
NWTPH-Gx = Northwest total petroleum hydrocarbon–gasoline
NWTPH-Dx = Northwest total petroleum hydrocarbon–diesel-extended
SIM = selective ion method (necessary for lower detection limit)
1. Oil-range petroleum hydrocarbons include lubricating oil and heavy-oil-range hydrocarbons
2. If benzene is present, the cleanup level is 800 µg/L. If no detectable benzene is present, the cleanup level is 1,000 µg/L.

monitoring well AB-12, located north of the project area, at a concentration of 7.5 µg/L, which is greater than the MTCA Method A cleanup level of 5 µg/L.

The groundwater samples were analyzed for both total and dissolved metals. Because of the high turbidity associated with groundwater samples collected with a Geoprobe®, elevated concentrations of total metals may not be representative of actual groundwater conditions. Therefore, the samples were also analyzed for dissolved metals to assess the impact of the sampling technique.

Five metals (arsenic, cadmium, chromium, lead, and mercury) were detected at concentrations greater than the MTCA Method A cleanup levels in groundwater samples collected along the build alternatives alignment. A summary of the metals results is provided in Exhibit 4-10. To support the permitting efforts, in 2010/2011 WSDOT conducted a study to determine baseline groundwater quality in the south portal area. Nine monitoring wells were evaluated; five were completed in the shallow aquifer and four were completed in the deep aquifer. Groundwater samples were analyzed for 13 priority pollutant metals, diesel, gasoline, and VOCs. The findings from this study will be used to evaluate groundwater management options that will comply with the permit requirements. The study will be available in 2011.

Exhibit 4-10. Groundwater Samples With Concentrations of Metals Exceeding MTCA Method A Cleanup Levels

Metal		Maximum Concentration (µg/L)	MTCA Method A Cleanup Level (µg/L)	Percentage Exceeding MTCA Method A Cleanup Level[1]
Arsenic	Total	51	5	14
	Dissolved	39		10
Cadmium	Total	73	5	2
	Dissolved	1		NA
Chromium	Total	380	50	3
	Dissolved	51		<1
Lead	Total	84	15	5
	Dissolved	31		<1
Mercury	Total	2.1	2	<1
	Dissolved	2.9		<1

Notes: A blank cell indicates that the results for all samples were below the MTCA Method A cleanup level. If multiple samples were collected at one location, the highest value was selected and reviewed. The percentage was determined assuming one result for each monitoring well location.
µg/L = micrograms per liter
MTCA = Model Toxics Control Act
NA = not applicable. No groundwater samples exceeded the MTCA Method A cleanup level for dissolved cadmium.
[1] Percentage was calculated by dividing the number of detections exceeding the MTCA Method A cleanup level by 173, the number of monitoring wells sampled for metals.

Dissolved methane has been detected in 83 borings along the build alternative alignments. Concentrations ranged from 0.01 to 110 mg/L, with the highest concentrations encountered at monitoring wells TB-204 and TB-206 (located on Alaskan Way S., about 400 feet north of S. Royal Brougham Way). The results for methane are provided in Attachment F, Exhibit F-4. Hydrogen sulfide (H_2S) may also be present; it occurs in areas of natural degradation of wood waste (organic matter) and could be associated with the breakdown of bunker fuel. Abundant wood waste is present between Railroad Way S. and S. King Street.

Additional groundwater monitoring wells will be installed to screen for potential contaminants in groundwater that may affect discharge. The results will be evaluated and provided as part of the ongoing engineering design.

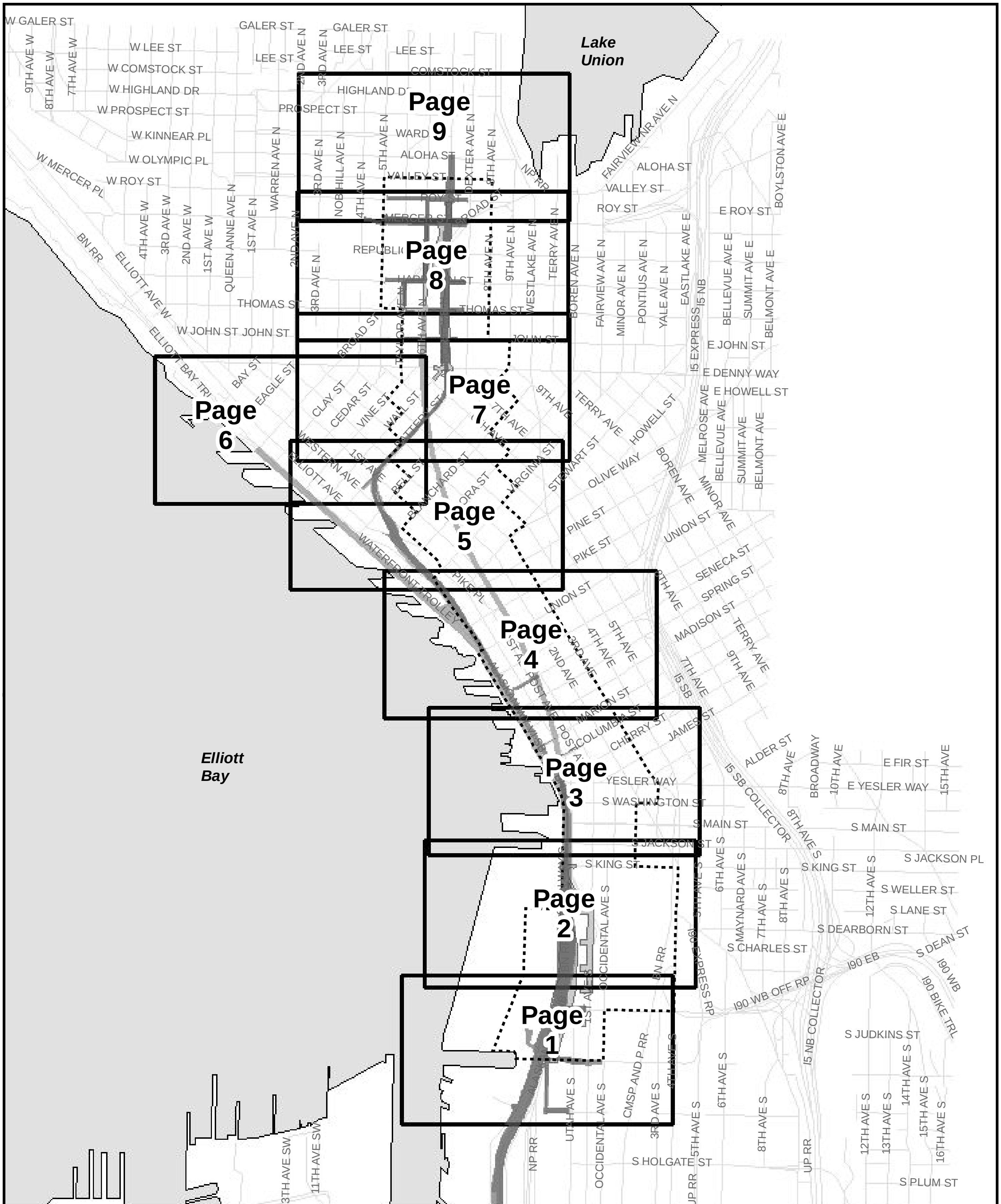
4.3 Historical Land Use

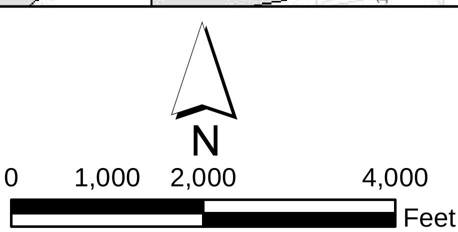
Historical land use activities in the study areas were reviewed to identify properties that have a high potential for contamination with hazardous substances. Information about historical land use was obtained by a review of data from public agencies and library resources. The land use of concern, source of information, documented years of operation, and potential contaminants for each site are provided in Attachment D. The location of each site, its potential contaminants, and its potential impact on the build alternative are shown on Exhibits 4-11, 4-12, and 4-13.

4.3.1 Contaminants of Concern

Based on historical activities, six general types of contaminants of concern have been identified in the study areas; these contaminant types have varying levels of toxicity and mobility that determine the significance of their presence to the project.

- **Mid- to heavy-range petroleum hydrocarbons (referred to in the text as oil).** These contaminants include diesel, bunker fuel, and lubricating oils. Their historical uses were widespread and associated with a variety of land uses. Diesel was used to heat businesses and homes. Bunker fuel was used to powered ships (bunker fuel is usually low-grade coal or heavy-oil). Lubricating oils were used extensively by the railroads. For the most part, these contaminants are relatively low in toxicity, are not particularly mobile, and tend to float on the water table rather than being dissolved or dispersed throughout the water column. As a result, any given leak or release of diesel or oil is not likely to have resulted in widespread contamination.





INDEX OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11
Sheet A

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LEGEND

(See attachments D and G for summaries of each site)

Risk to the Environment Hazardous Materials

Gasoline

Low to Moderate Risk

Moderate to High Risk

Solvents

Low to Moderate Risk

Moderate to High Risk

Petroleum (diesel and/or oil)

Low to Moderate Risk

Moderate to High Risk

Metals

Low to Moderate Risk

Moderate to High Risk

PCBs

Low to Moderate Risk

Moderate to High Risk

Pah

Low to Moderate Risk

Moderate to High Risk

Impact Ranking for Validated Sites:

-1 Low

-1 Moderate

-1 High

Documented Release

-2 Parcel w/Site Designation - if a site consists of multipal parcels, each parcel recieves the same site designation.

60.2 Block w/Designation

Study Areas

Cut-and-Cover and Elevated Structure Alternative Study Areas

Bored Tunnel Study Area

Alignments

Bored Tunnel Alignment

Elevated Structure Alignment

Cut-and-Cover Tunnel Alignment

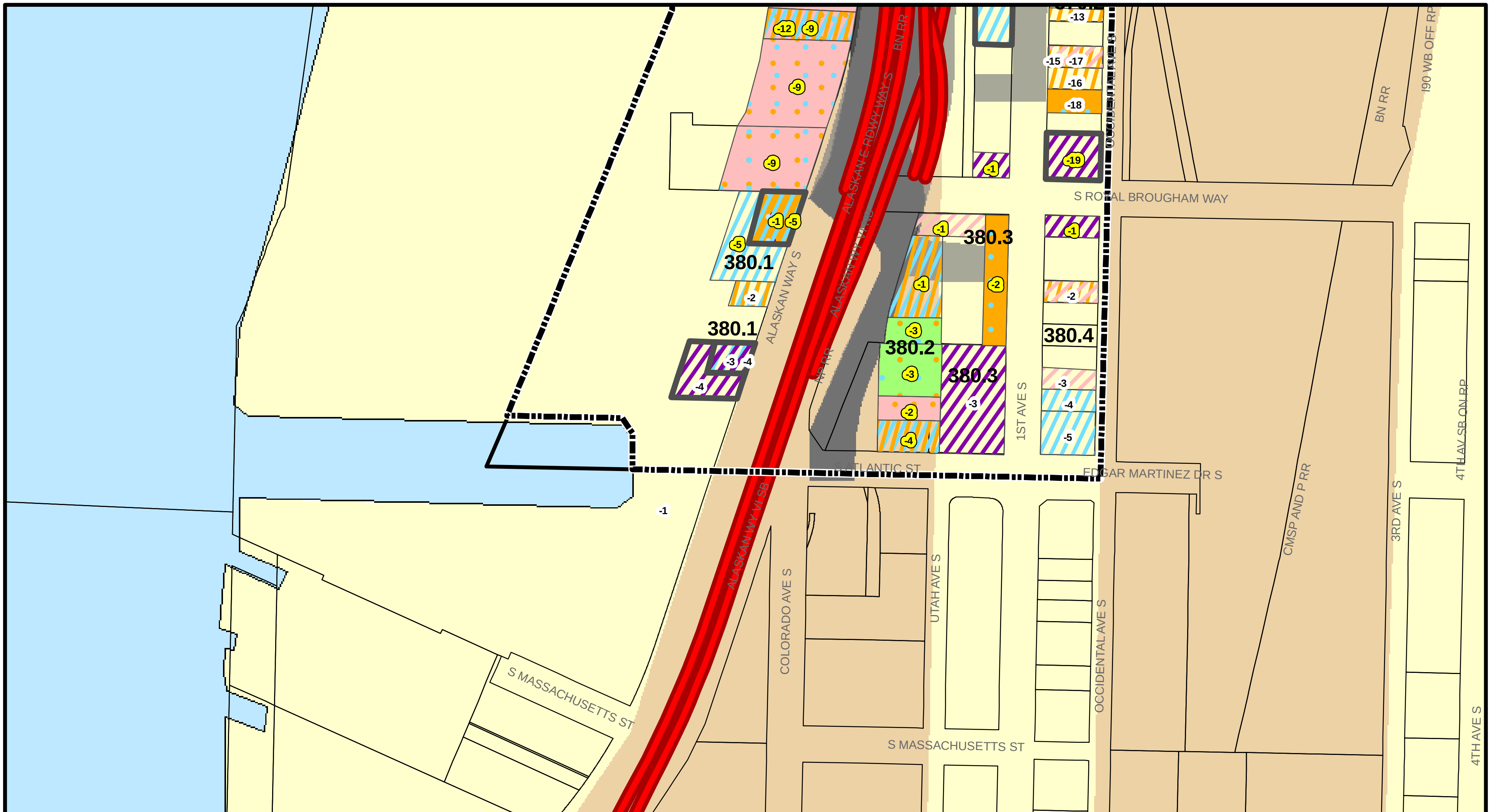
Alaskan Way Viaduct Program Element

Historic Railroad Use

Fill

LEGEND FOR SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALIGNMENT

Exhibit 4-11
Sheet B



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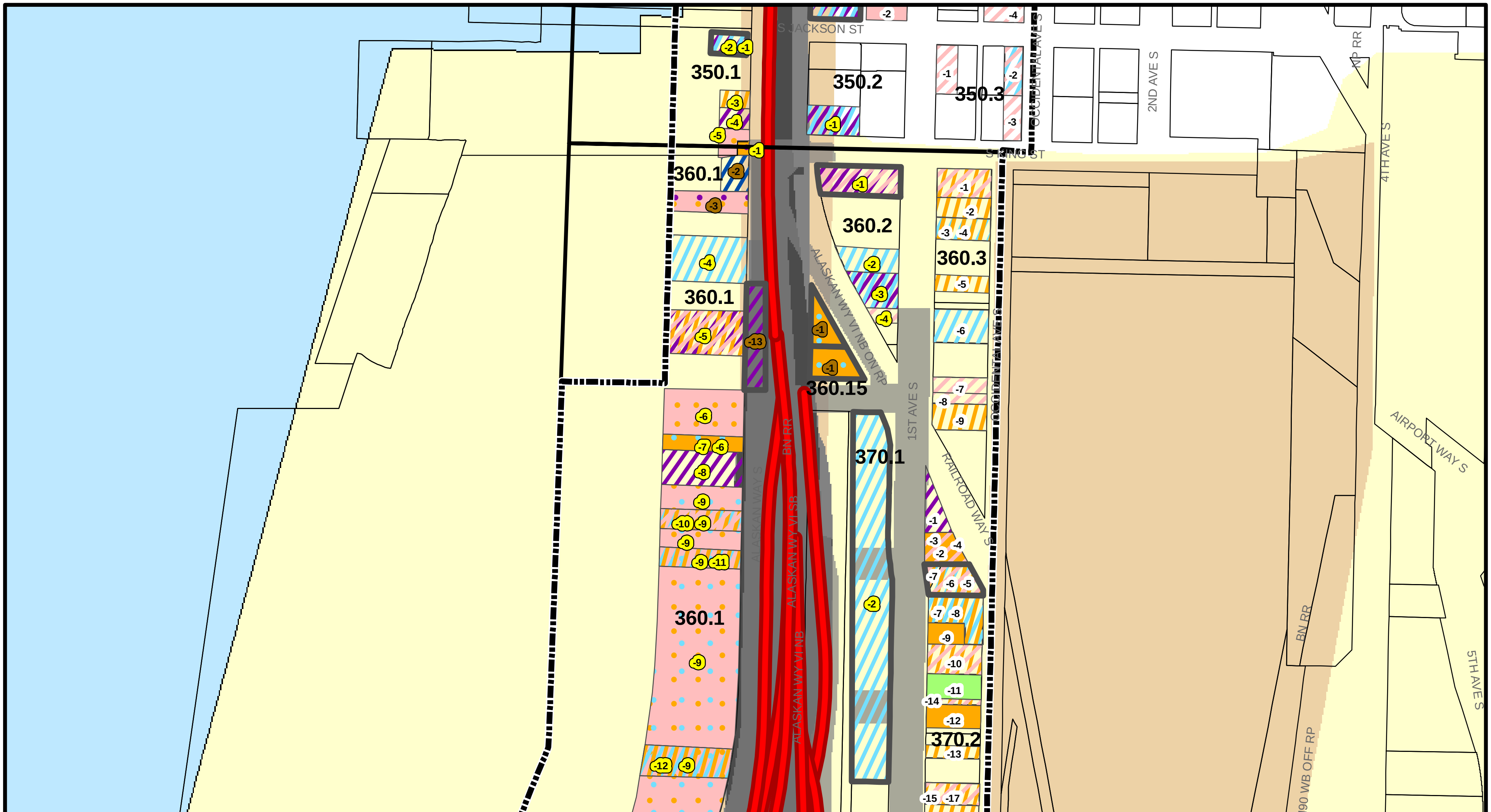
NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 1 of 9



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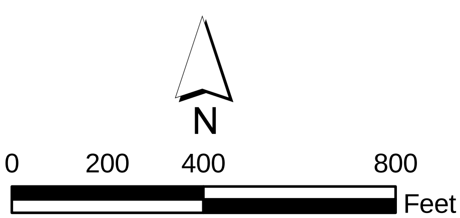
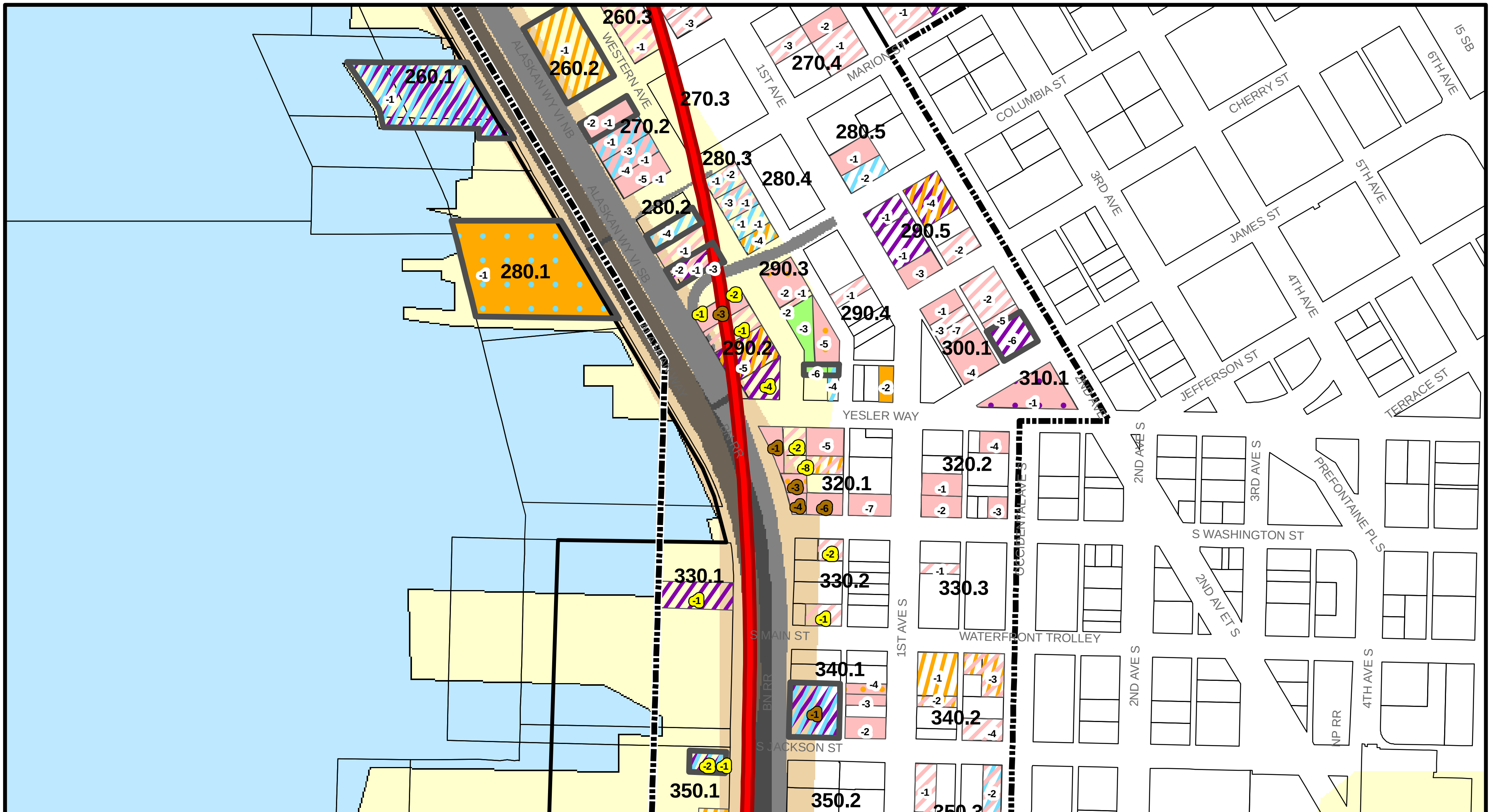


NOTE: See Exhibit 4-11 Sheet B
for Legend of Documented and
Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 2 of 9



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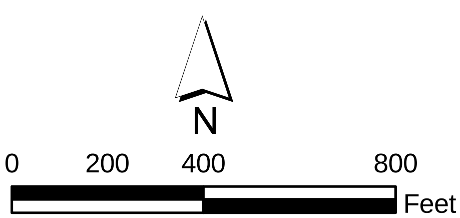
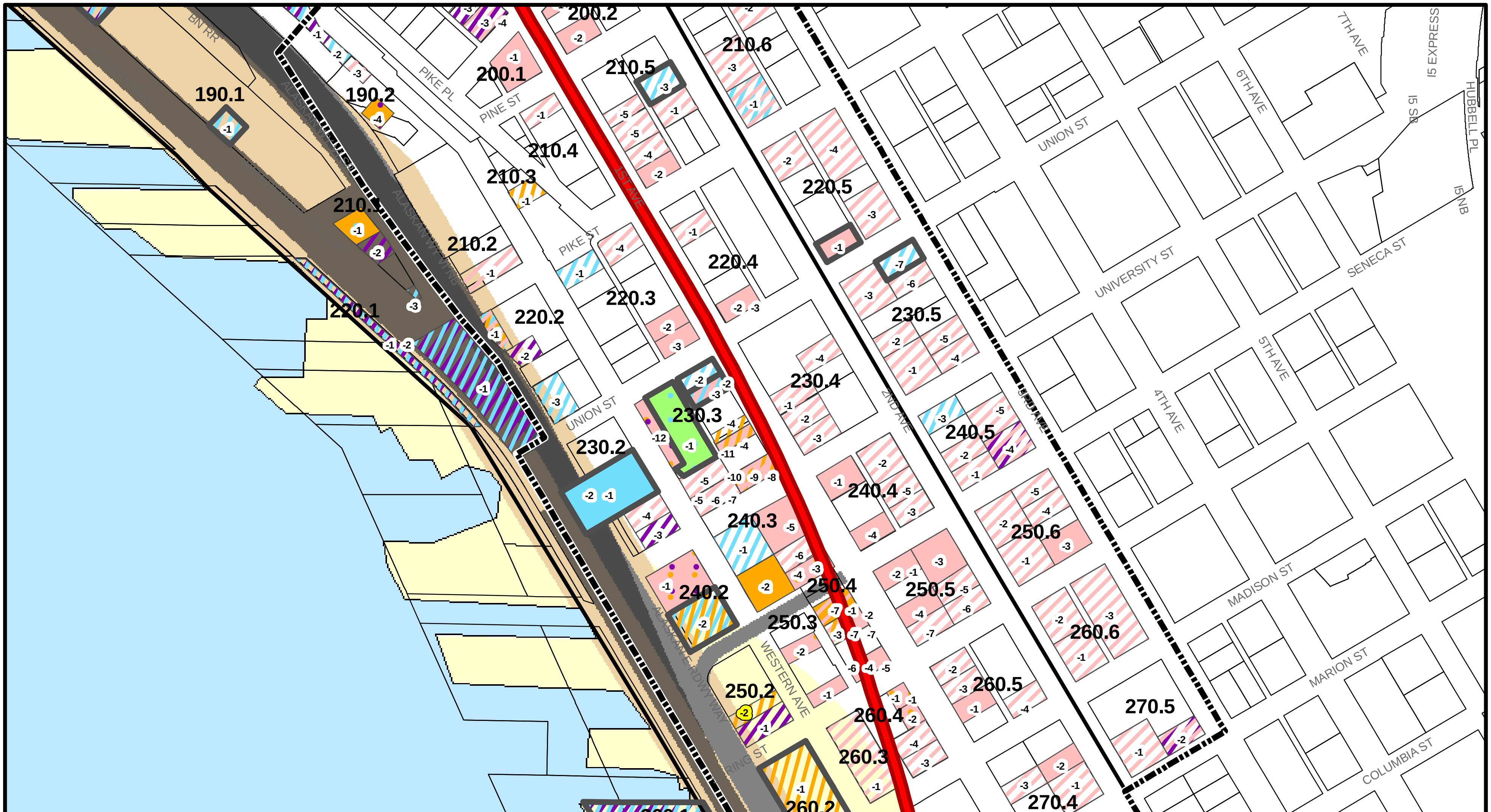


NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 3 of 9



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NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 4 of 9

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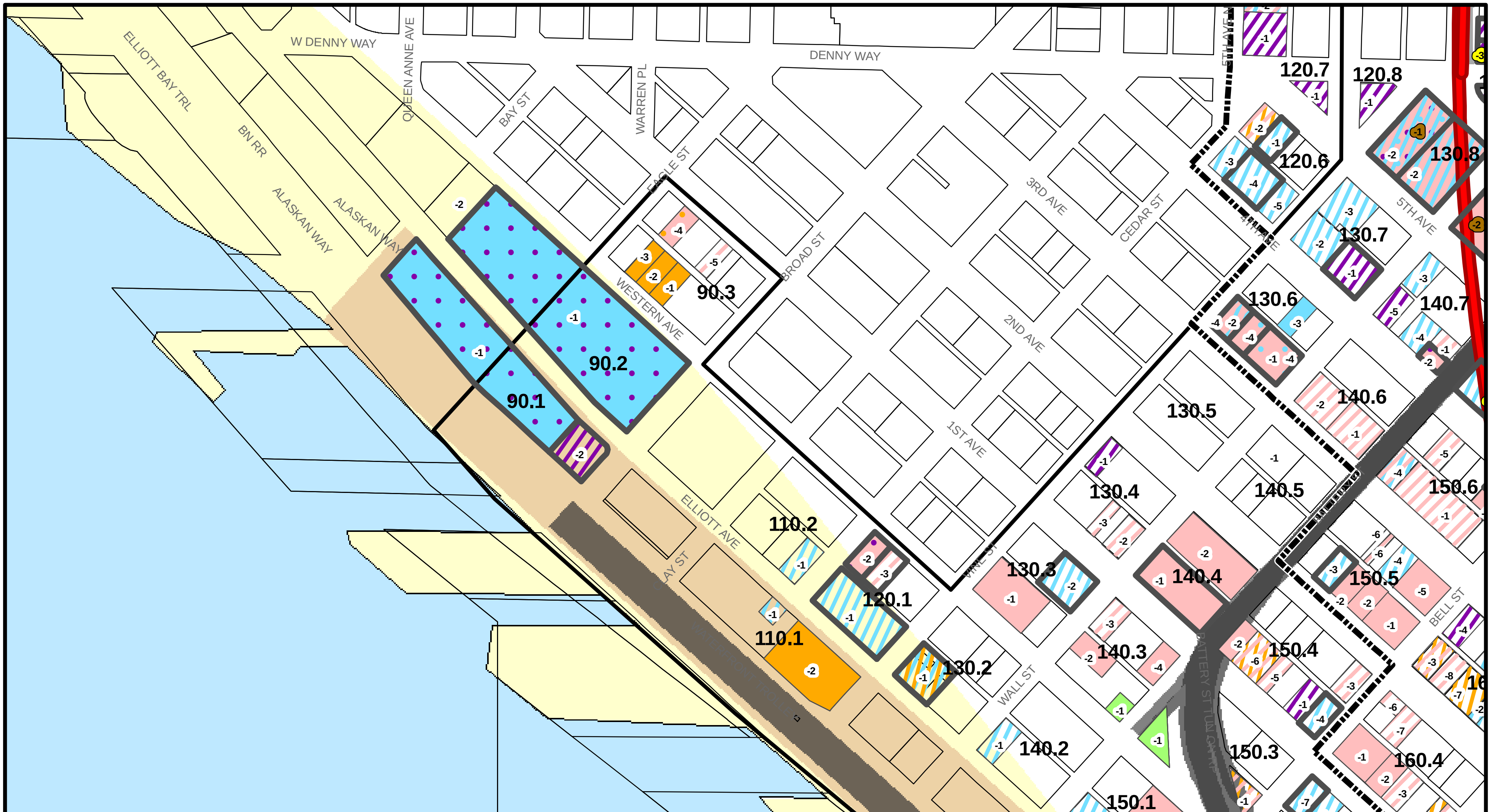
NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 5 of 9



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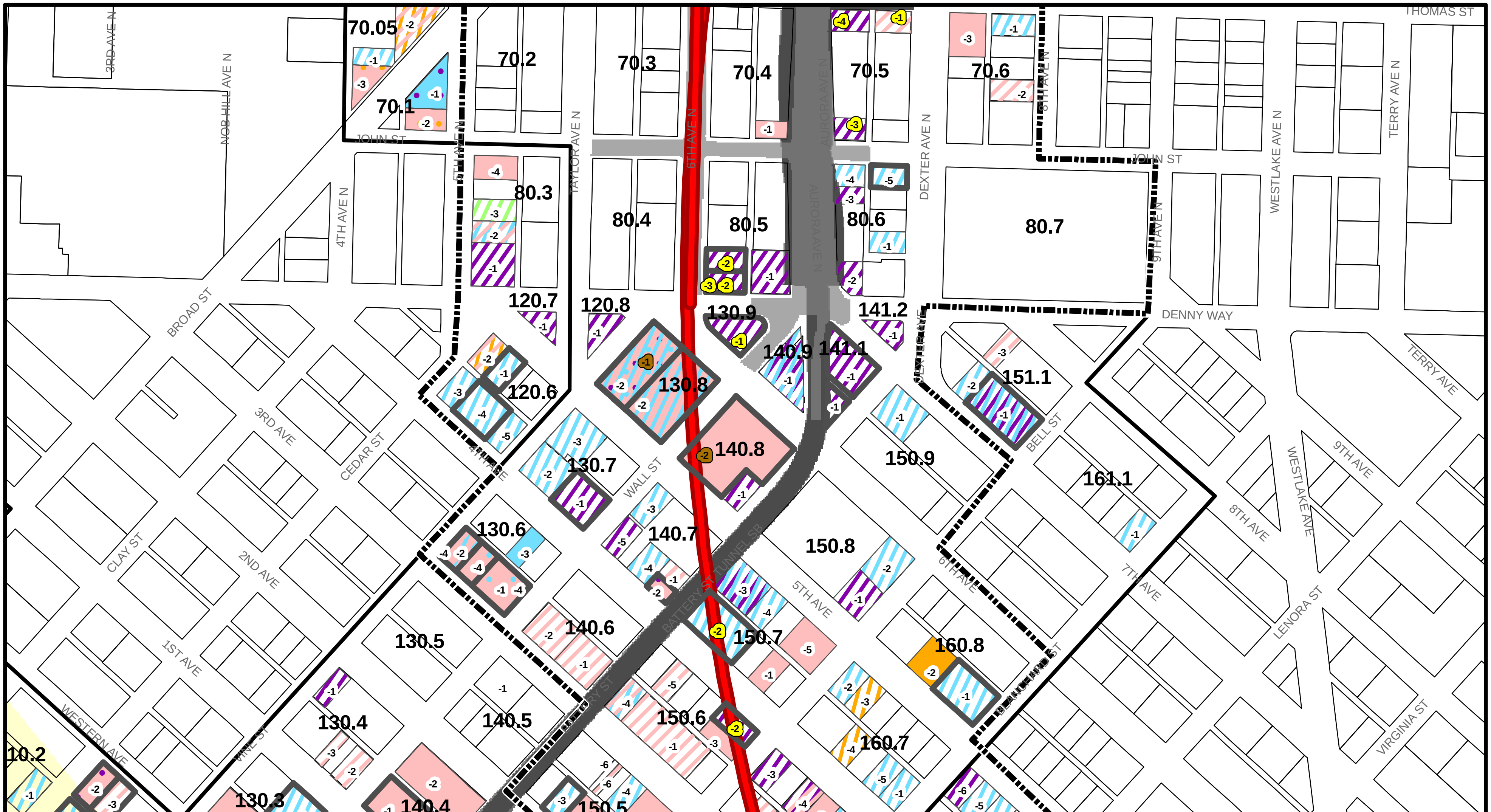
NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11



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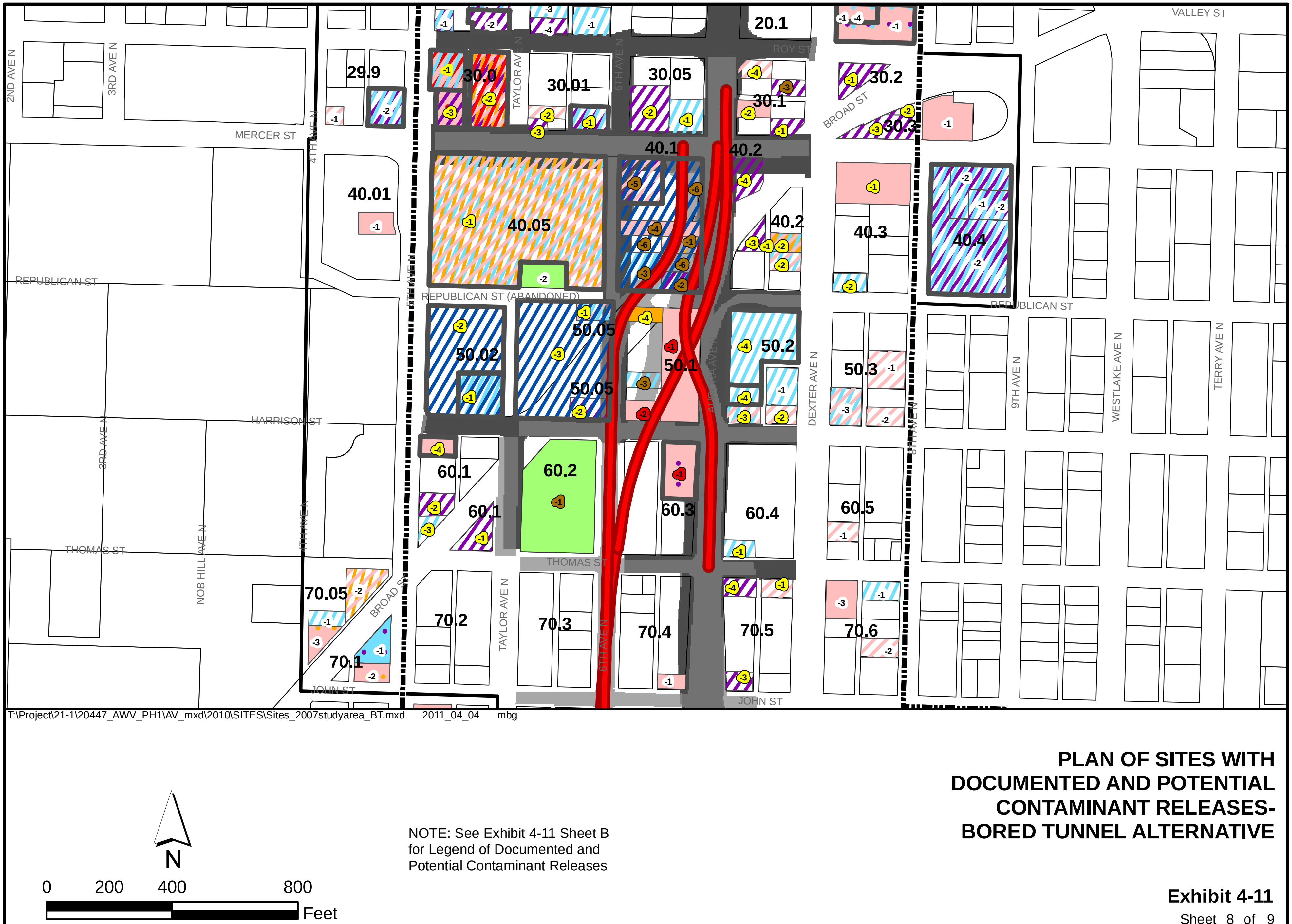
NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 7 of 9



NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11

Sheet 8 of 9

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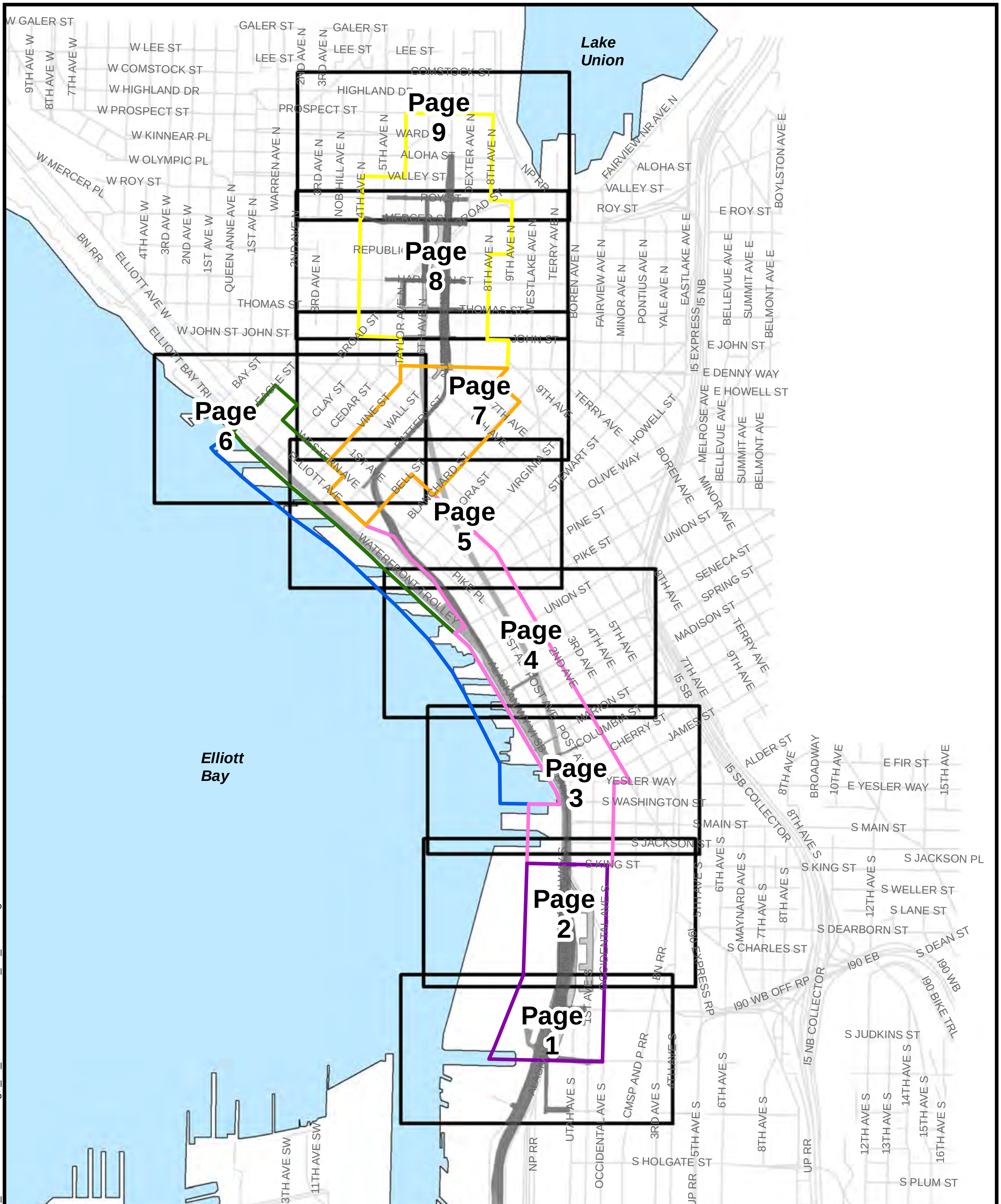
NOTE: See Exhibit 4-11 Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- BORED TUNNEL ALTERNATIVE

Exhibit 4-11



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INDEX OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT AND COVER TUNNEL ALTERNATIVE

Exhibit 4-12
Sheet A

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LEGEND

(See attachments D and G for summaries of each site)

Risk to the Environment Hazardous Materials

Gasoline

Low to Moderate Risk

Moderate to High Risk

Solvents

Low to Moderate Risk

Moderate to High Risk

Petroleum (diesel and/or oil)

Low to Moderate Risk

Moderate to High Risk

Metals

Low to Moderate Risk

Moderate to High Risk

PCBs

Low to Moderate Risk

Moderate to High Risk

Pah

Low to Moderate Risk

Moderate to High Risk

Impact Ranking for Validated Sites:

-1 Low

-1 Moderate

-1 High

Documented Release

-2 Parcel w/Site Designation - if a site consists of multipal parcels, each parcel recieves the same site designation.

60.2 Block w/Designation

Alignments

Cut-and-Cover Tunnel Alignment

Bored Tunnel Alignment

Elevated Structure Alignment

Alaskan Way Viaduct Program Element

Historic Railroad Use

Fill

Corridor Zones

BST

Central

North

North Waterfront

Sea Wall

South

SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES CUT-AND-COVER TUNNEL ALTERNATVE

Exhibit 4-12

Sheet B

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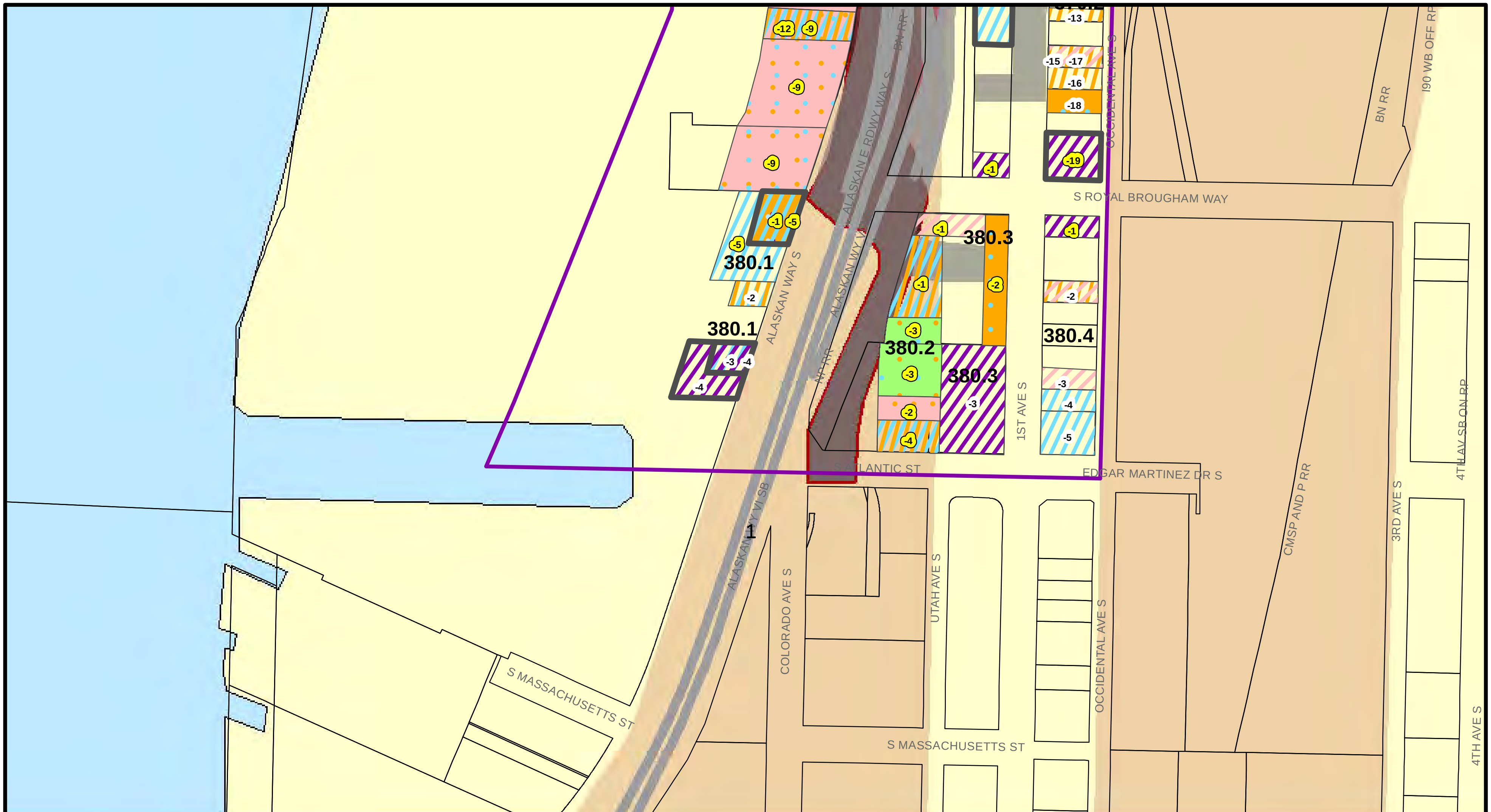

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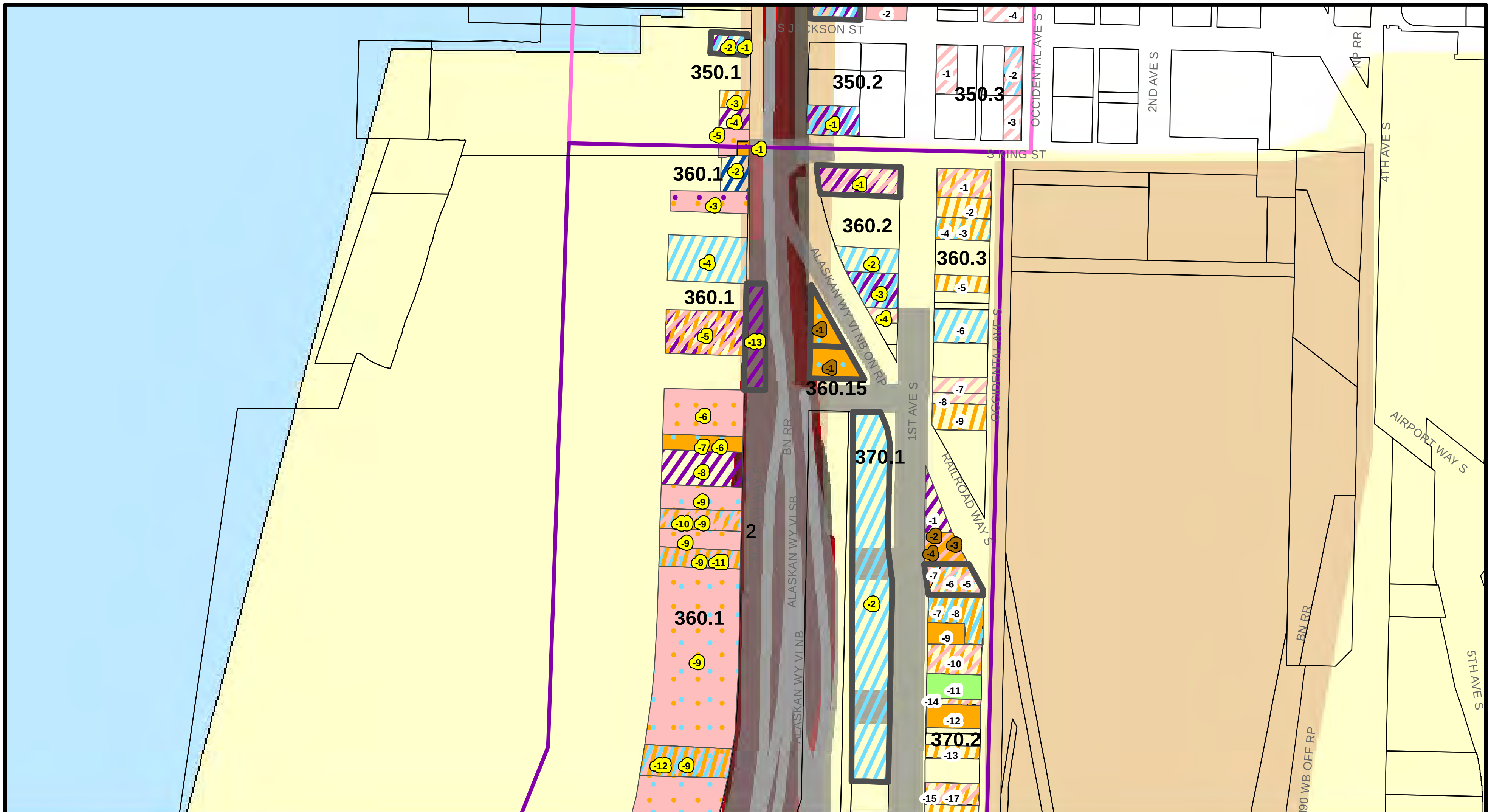
NOTE: See Exhibit 4-12, Sheet B for Legend of Documented and Potential Contaminant Releases

PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

Exhibit 4-12

Sheet 1 of 9



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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

Exhibit 4-12

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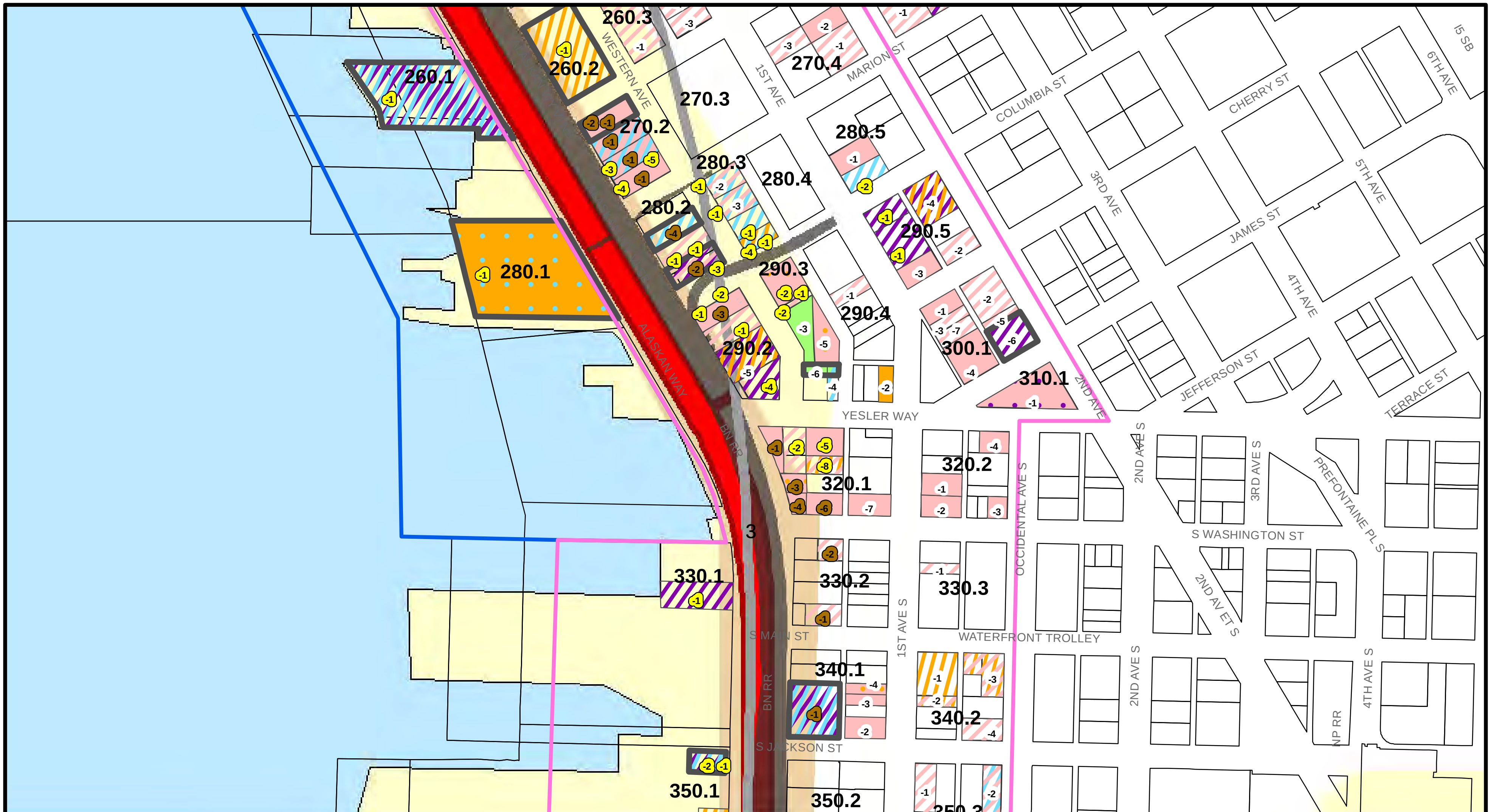

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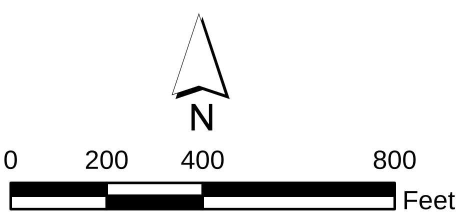

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

Exhibit 4-12

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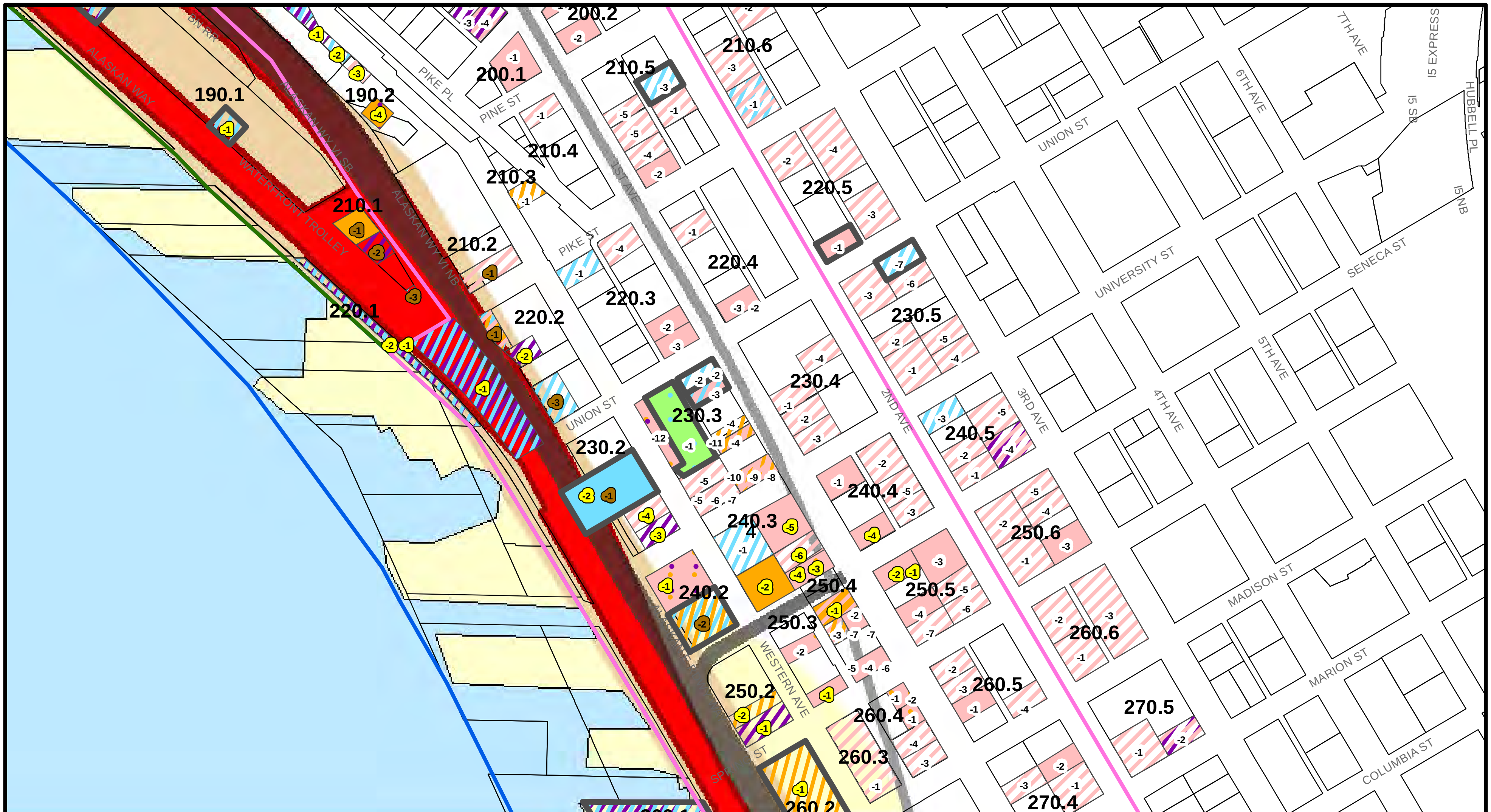

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

Exhibit 4-12

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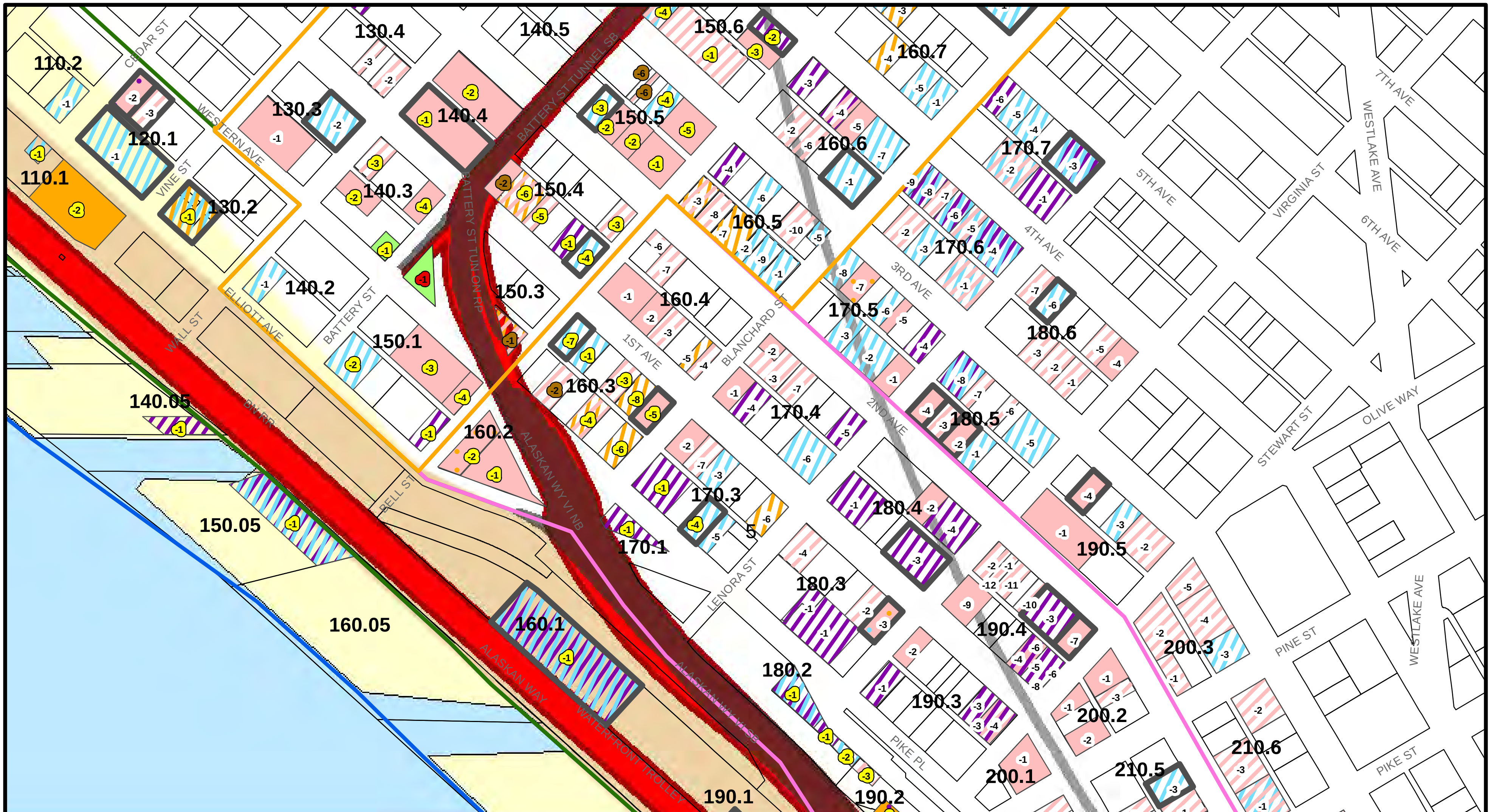

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

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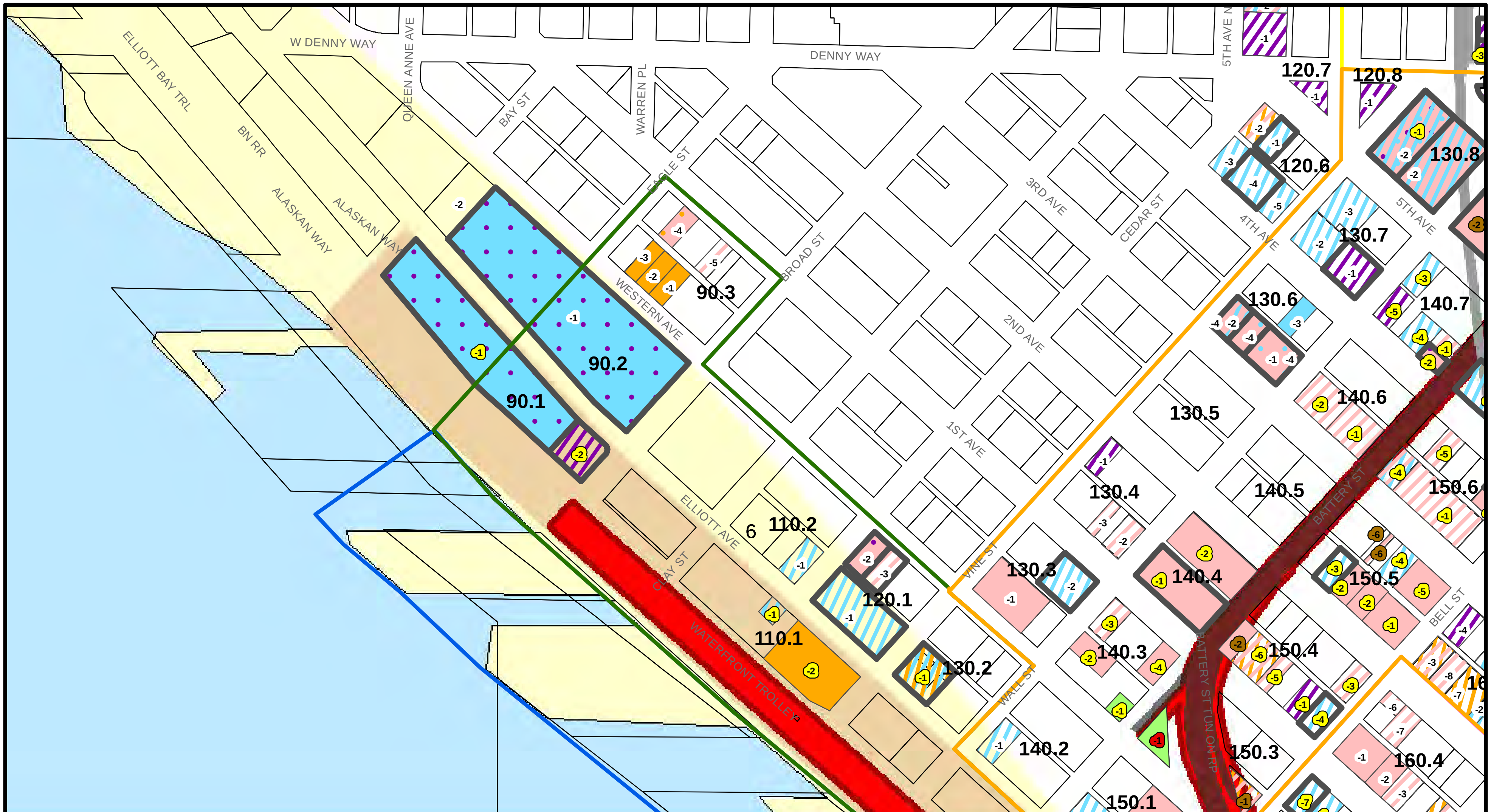
Sheet 5 of 9



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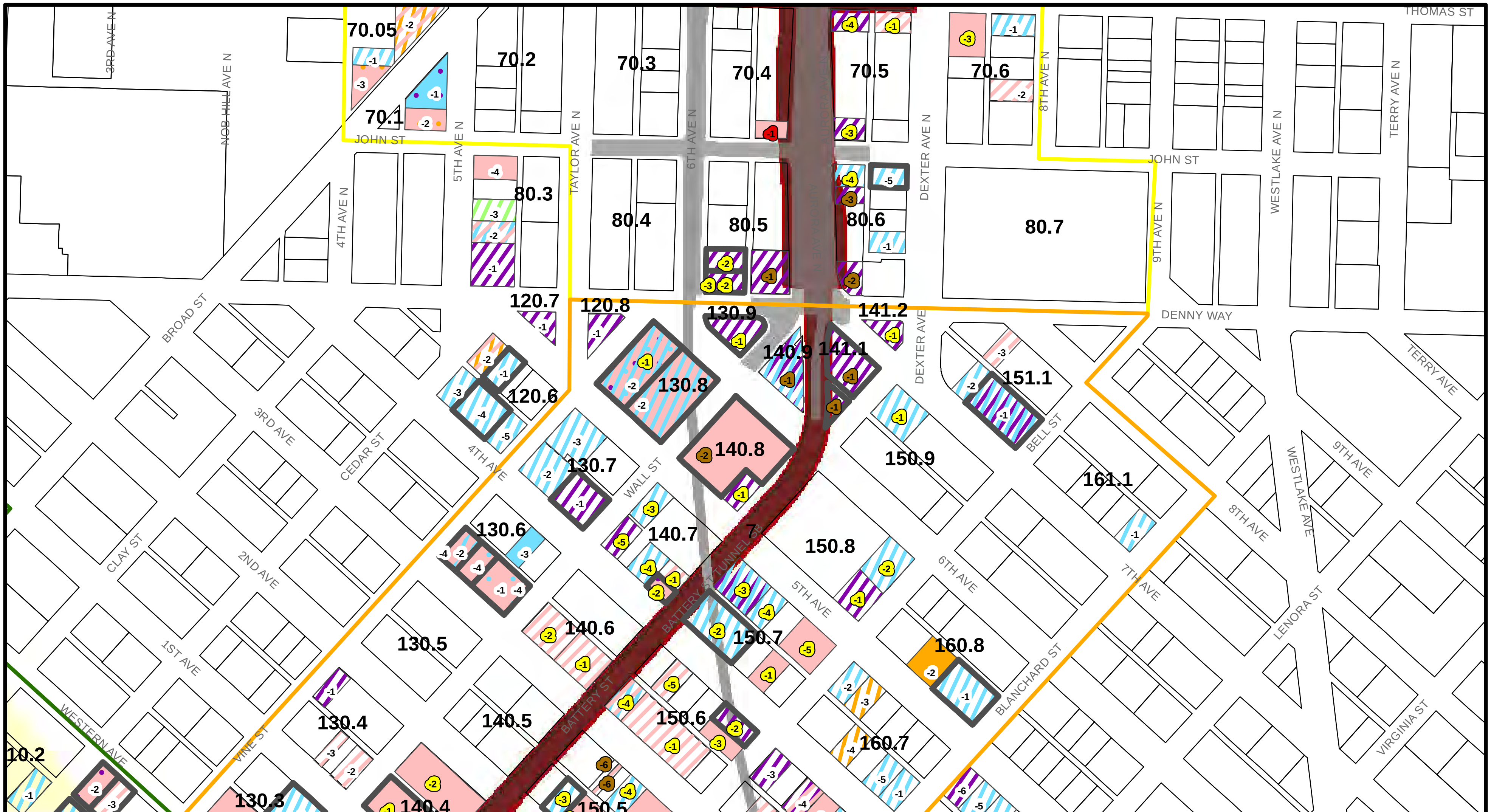

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

Exhibit 4-12
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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- CUT-AND-COVER TUNNEL ALTERNATIVE

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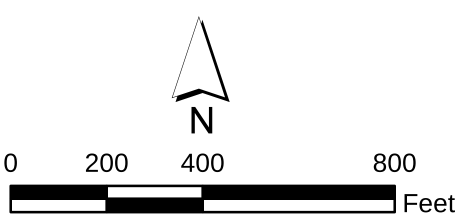

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES-CUT-AND-COVER TUNNEL ALTERNATIVE

Exhibit 4-12

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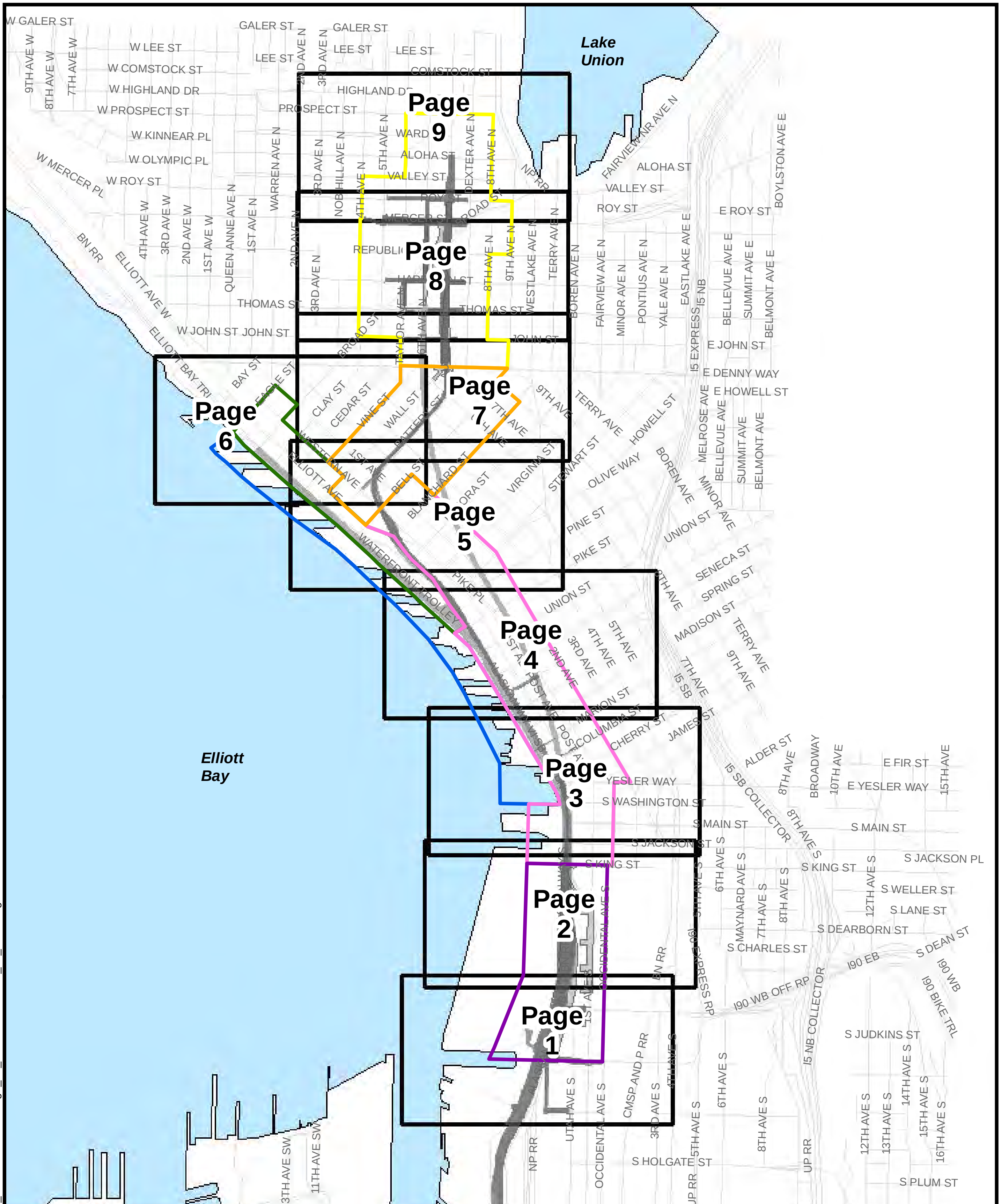

INDEX OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

Exhibit 4-13
Sheet A

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LEGEND

(See attachments D and G for summaries of each site)

Risk to the Environment Hazardous Materials

Gasoline

- Low to Moderate Risk
- Moderate to High Risk

Solvents

- Low to Moderate Risk
- Moderate to High Risk

Petroleum (diesel and/or oil)

- Low to Moderate Risk
- Moderate to High Risk

Metals

- Low to Moderate Risk
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- Low to Moderate Risk
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Impact Ranking for Validated Sites:

- -1 Low
- -1 Moderate
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- Documented Release
- -2 Parcel w/Site Designation - if a site consists of multipal parcels, each parcel recieves the same site designation.
- 60.2 Block w/Designation

Corridor

- BST
- Central
- North
- North Waterfront
- Seawall
- South

Alignments

- Elevated Structure Alignment
- Bored Tunnel Alignment
- Cut-and-Cover Tunnel Alignment
- Alaskan Way Viaduct Program Element
- Historic Railroad Use
- Fill

LEGEND FOR SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

Exhibit 4-13
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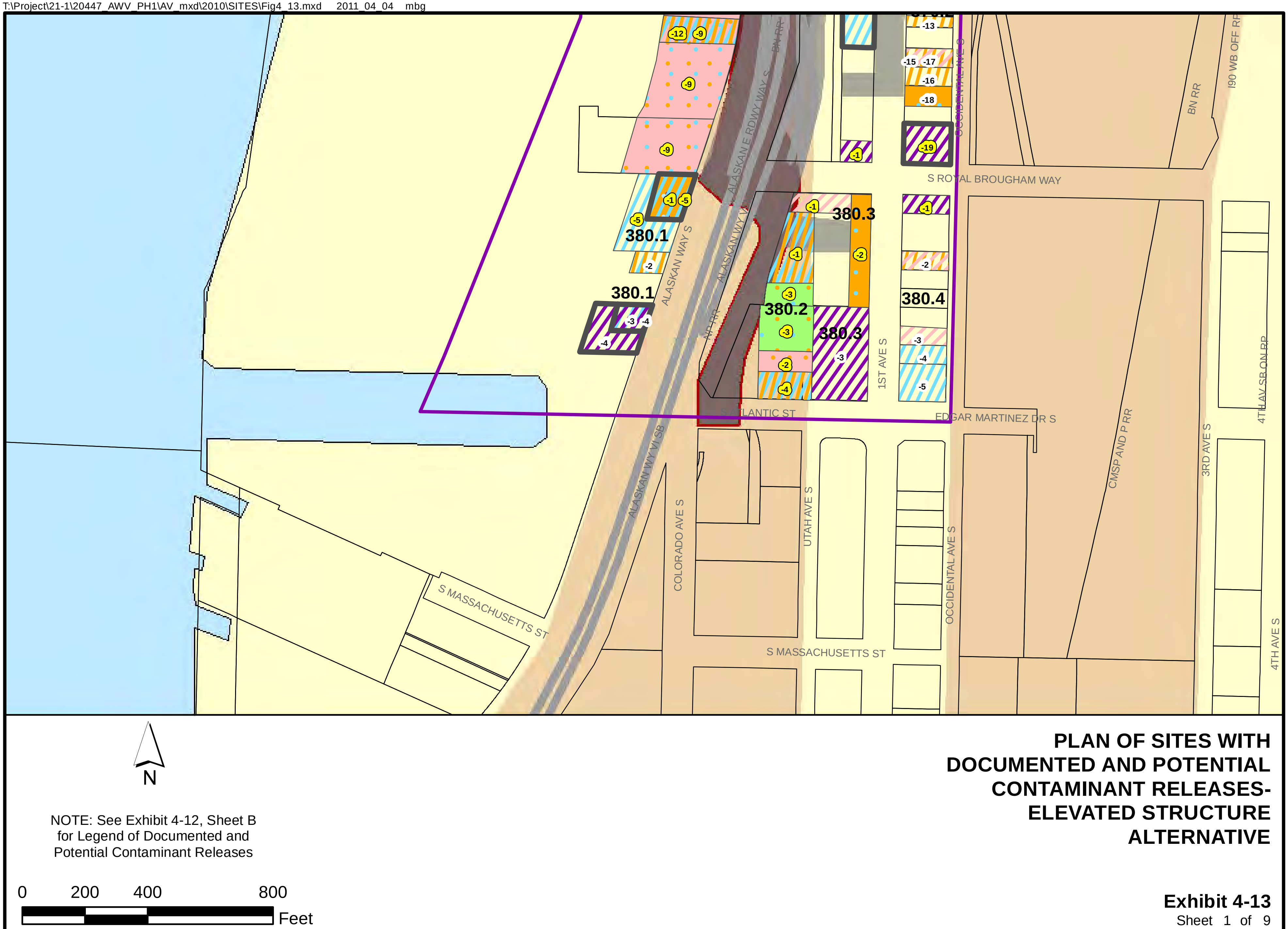

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

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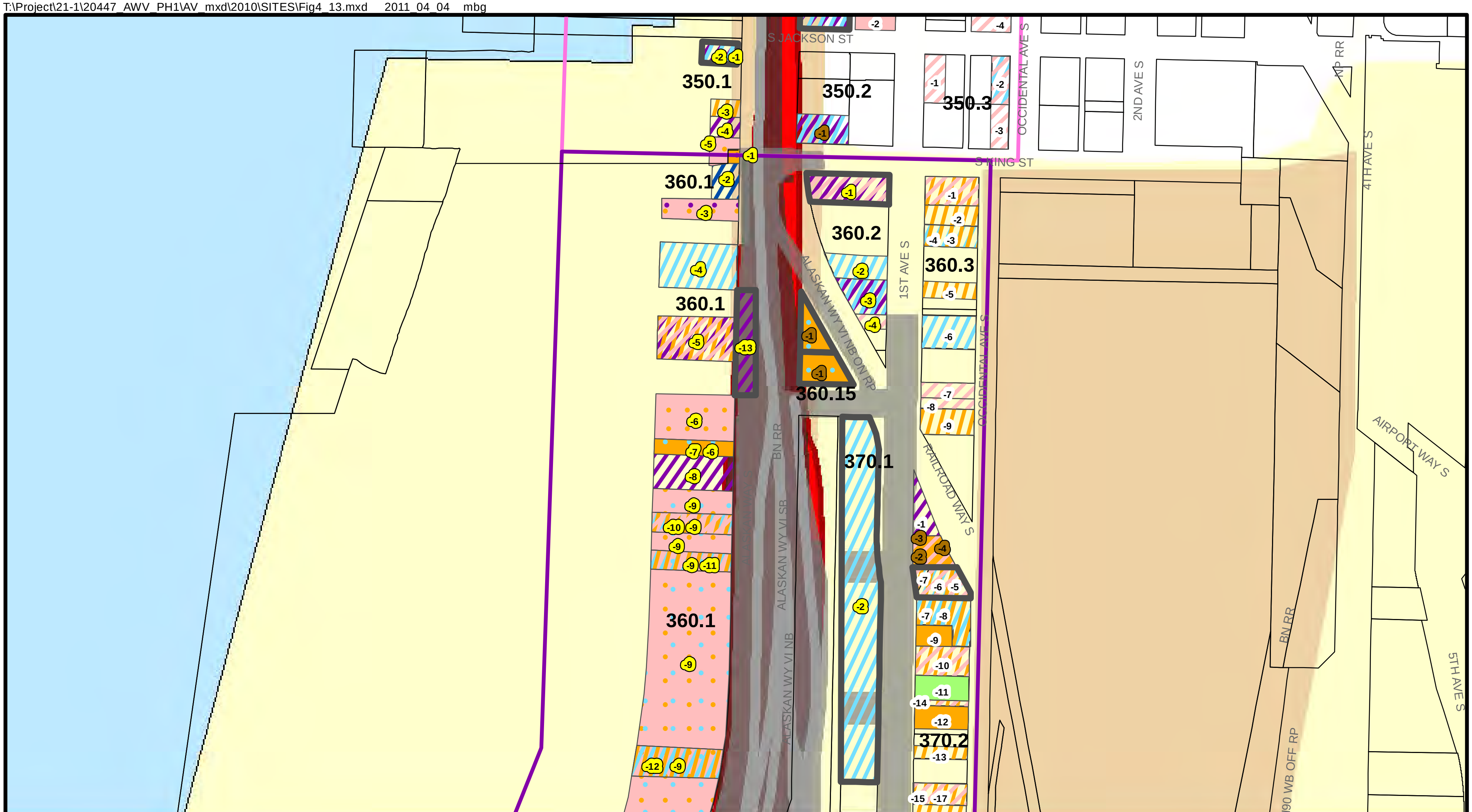

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

Exhibit 4-13

Sheet 2 of 9

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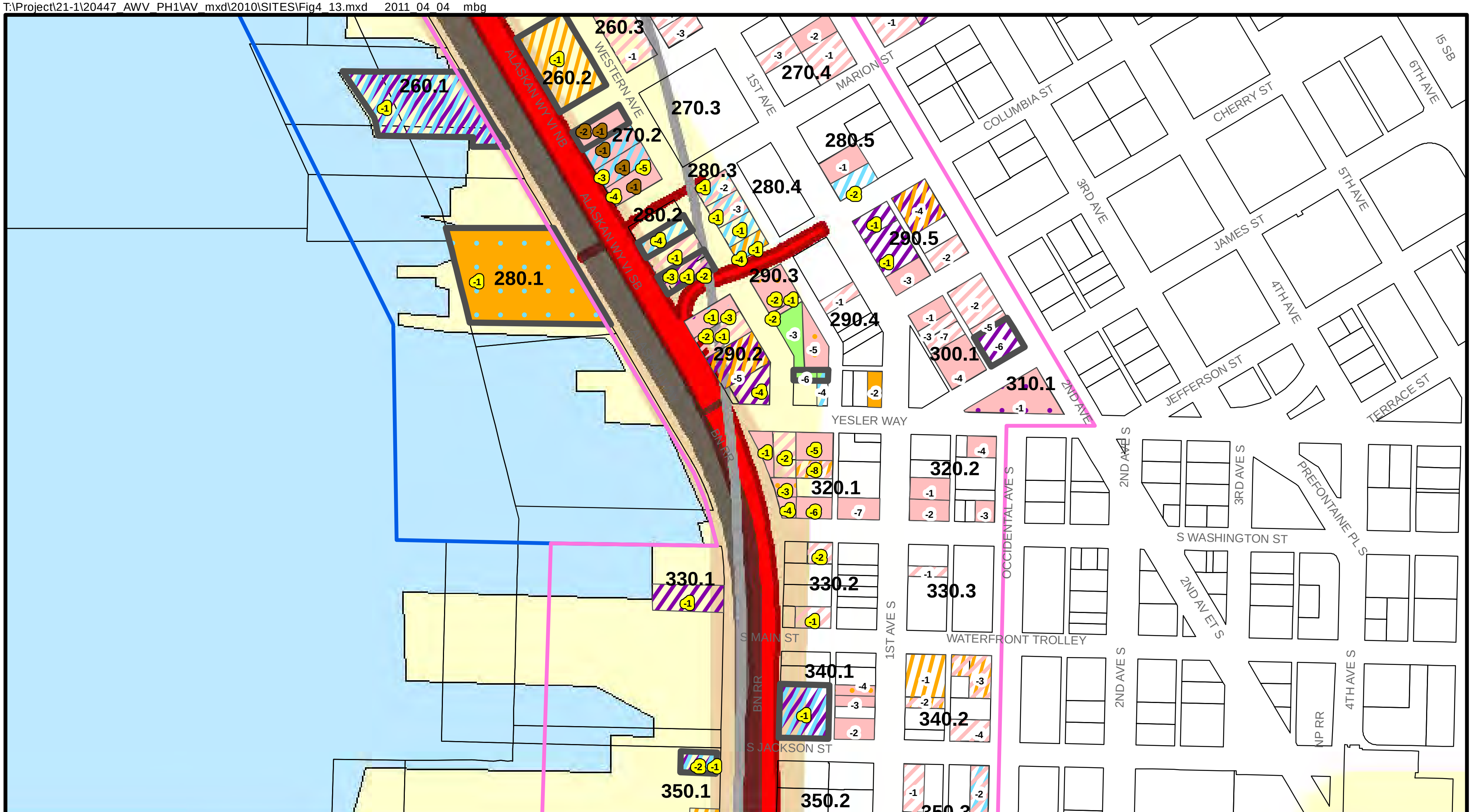

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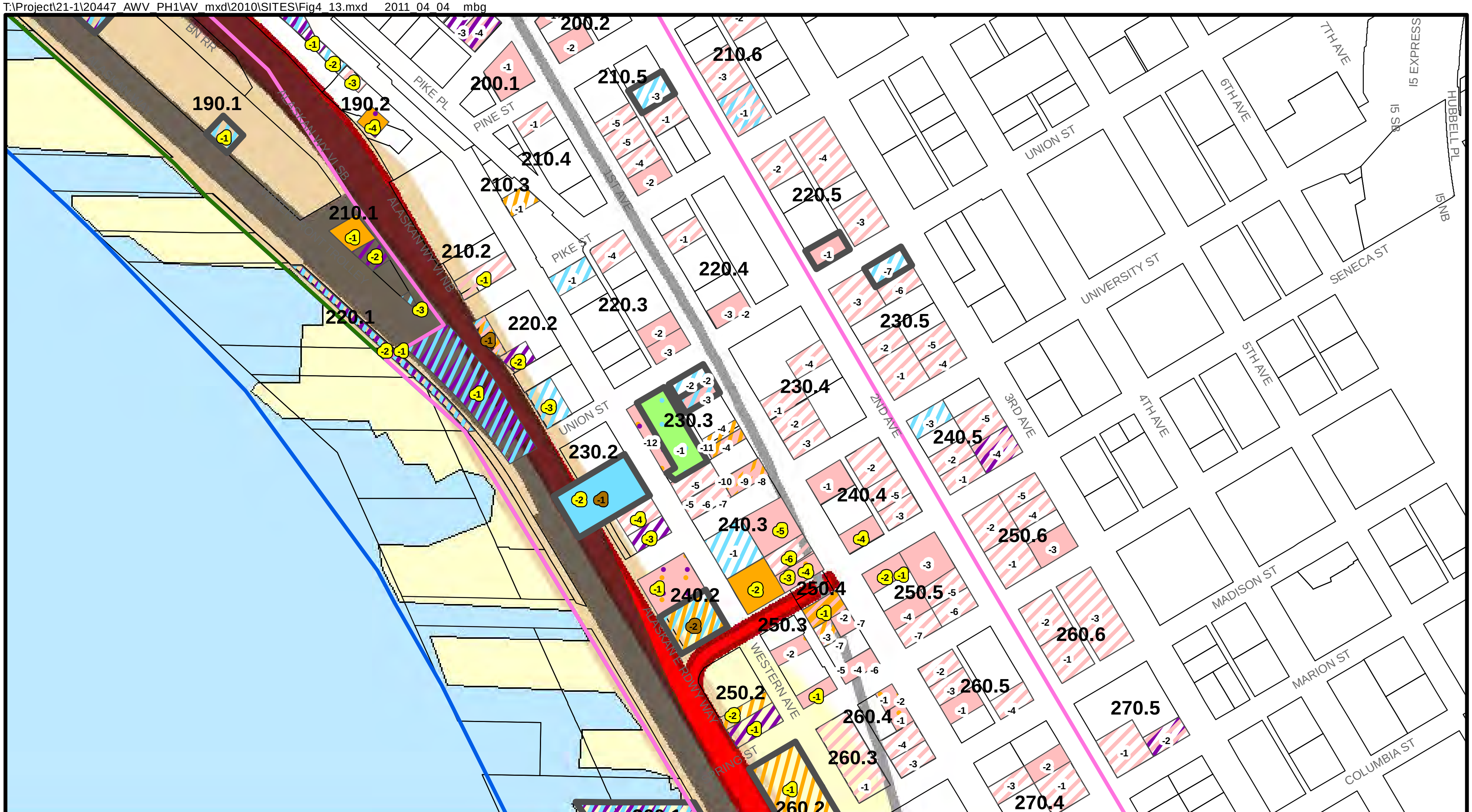

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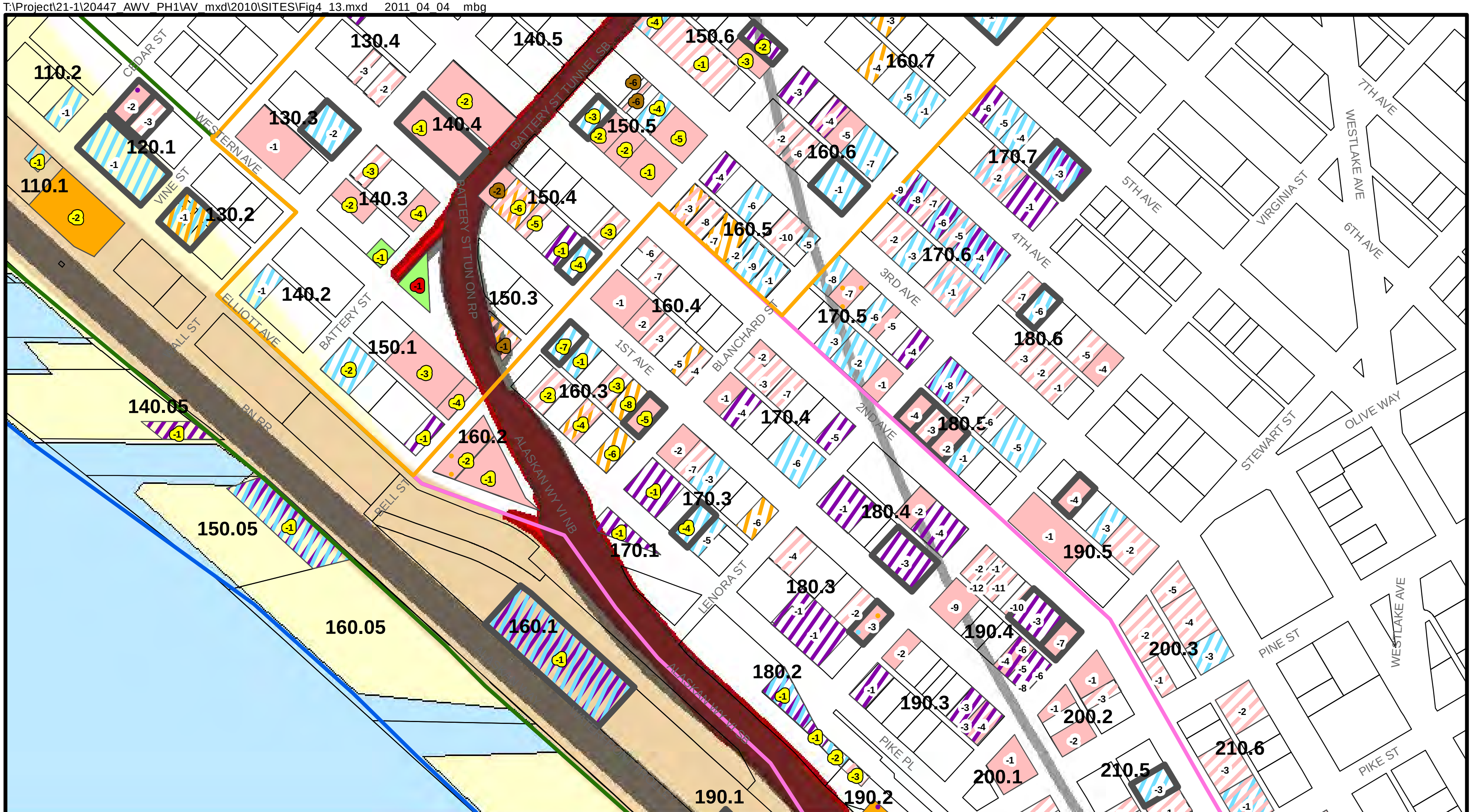

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

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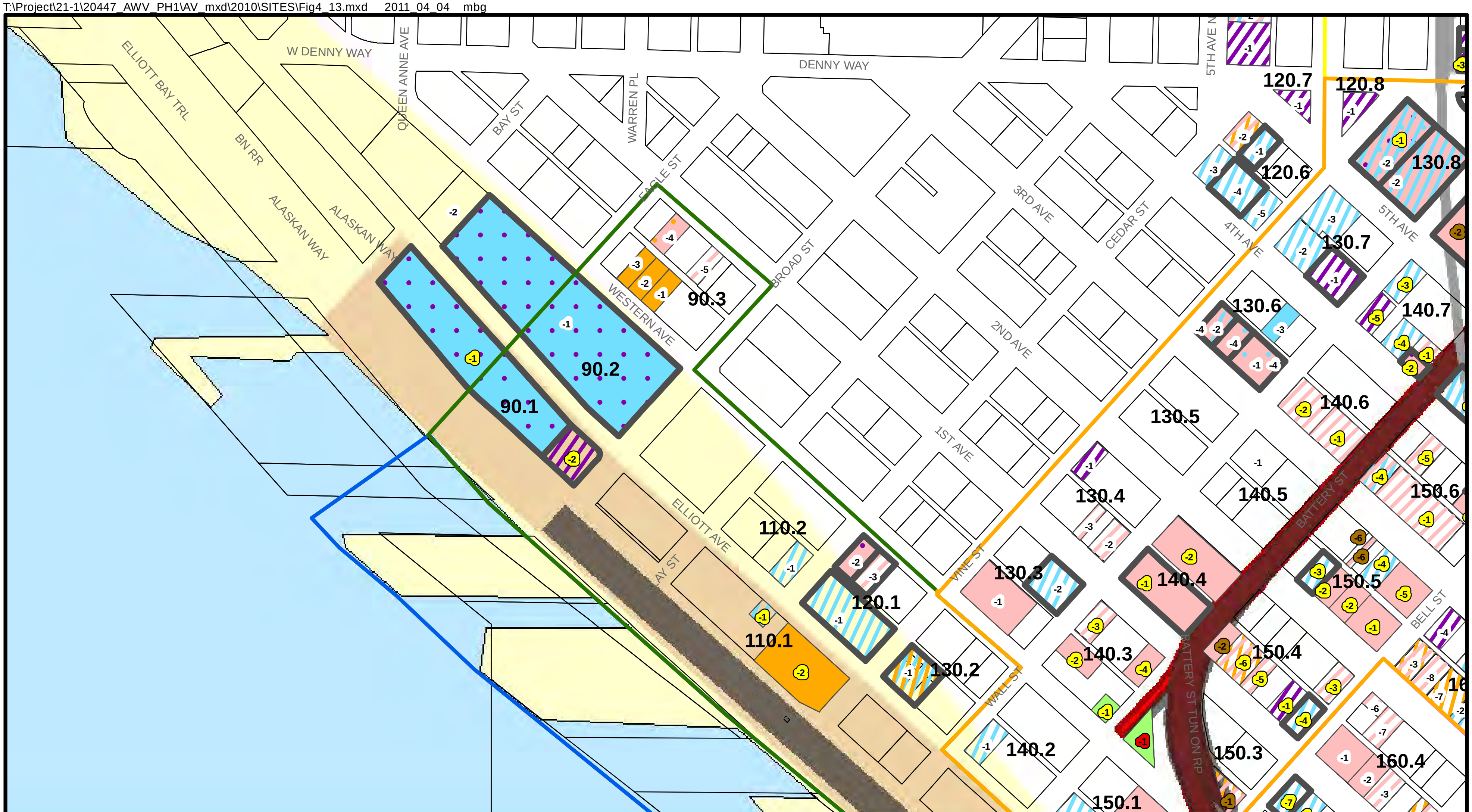

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

Exhibit 4-13

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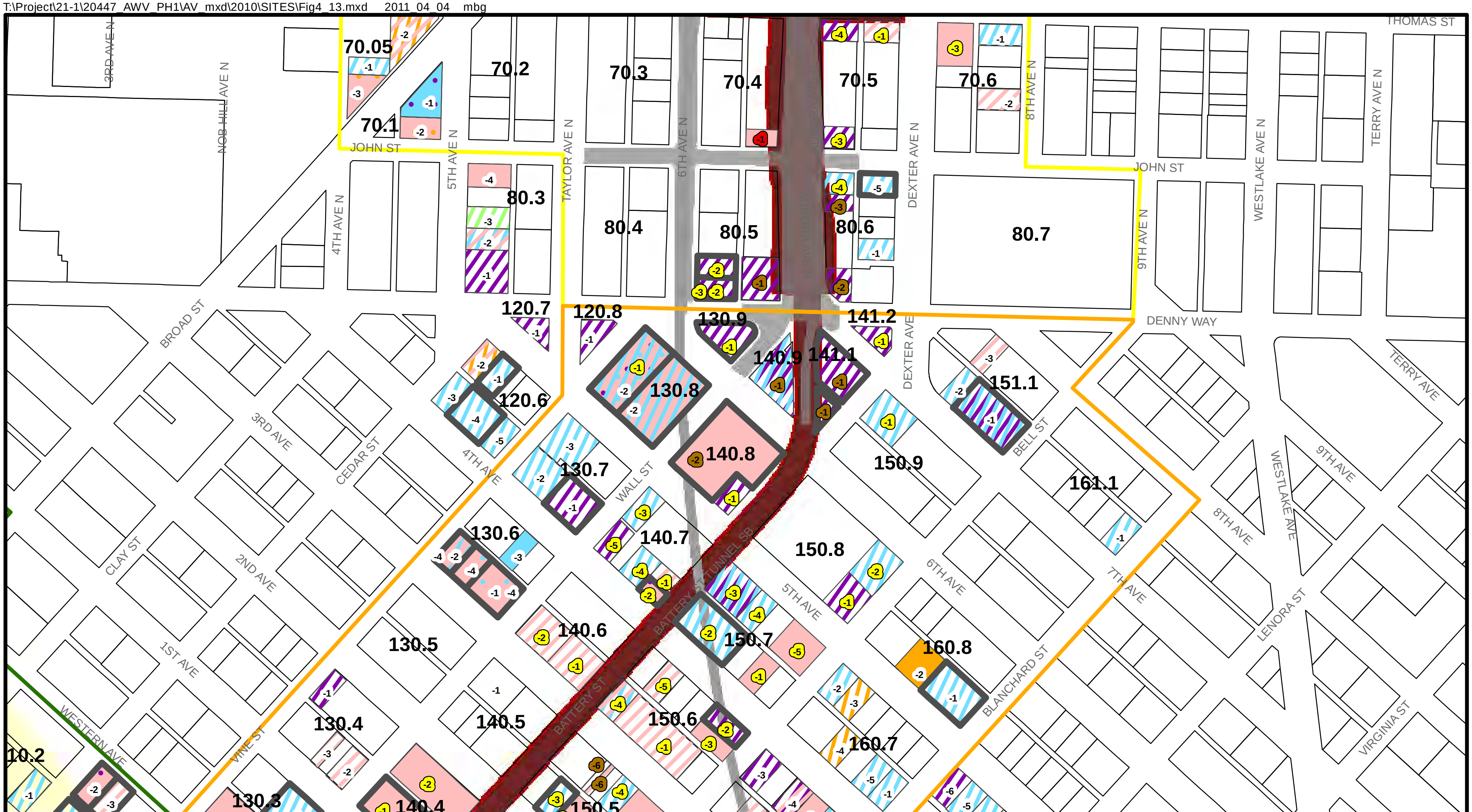

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

Exhibit 4-13

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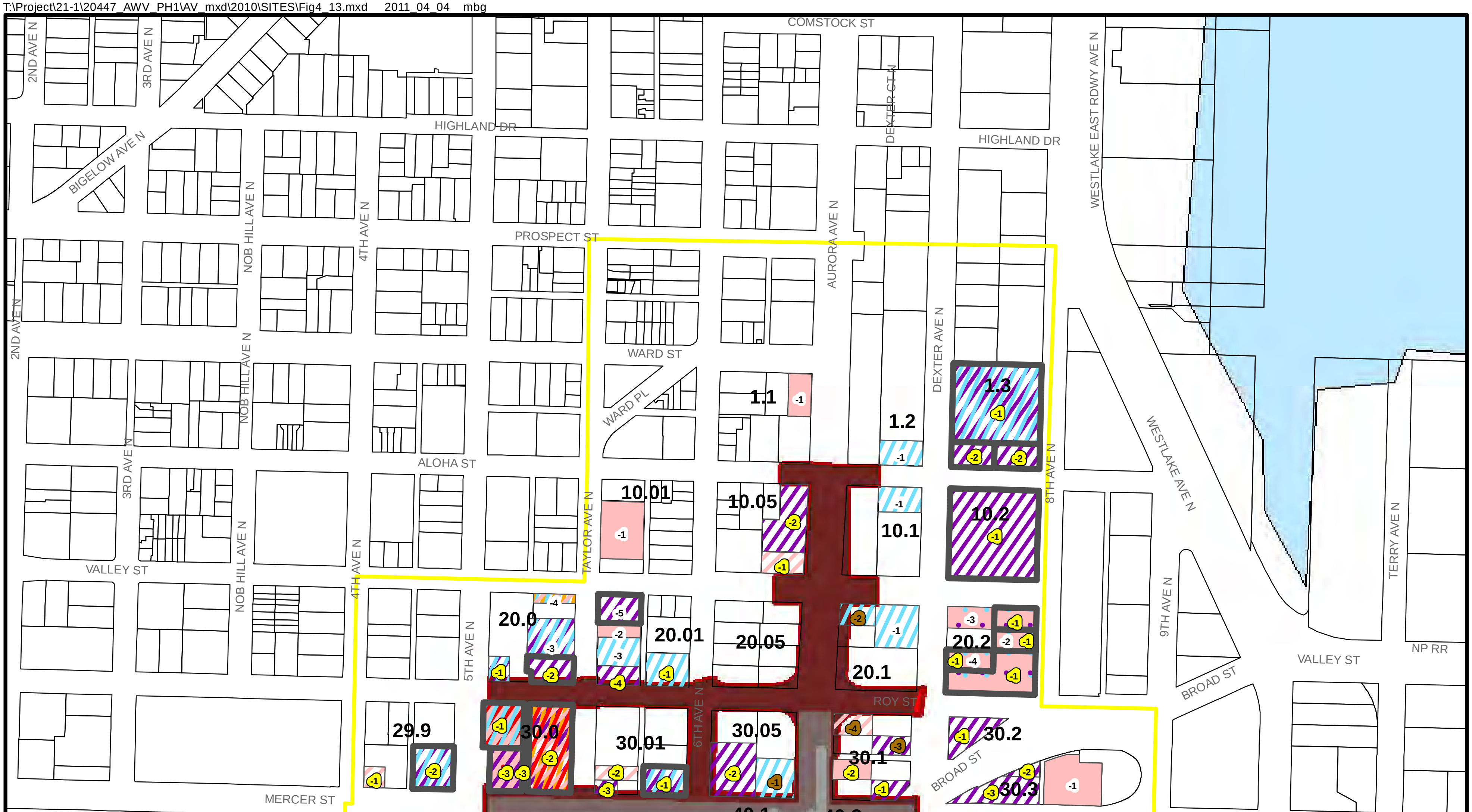

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PLAN OF SITES WITH DOCUMENTED AND POTENTIAL CONTAMINANT RELEASES- ELEVATED STRUCTURE ALTERNATIVE

Exhibit 4-13

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- **Gasoline.** Gasoline contamination generally results from leaks and spills associated with former gas stations and vehicle maintenance facilities. Gasoline is relatively mobile in the environment and is more toxic at lower concentrations than heavier grades of hydrocarbons. Gasoline also tends to float on the water table; however, more soluble components such as BTEX may be present, depending on the age of the release. These volatile compounds can pose a substantial risk to humans and the environment and are highly soluble and mobile in groundwater. They may also volatilize and become a vapor in the unsaturated soil column.
- **PAHs.** PAHs, some of which are carcinogenic, are present in heavy-oil range petroleum hydrocarbons and are created during burning because of incomplete combustion. They are also present in creosote. PAHs may be associated with petroleum releases such as leaking heating oil USTs, lubricating oils used by railroads, burned timbers, and creosote-treated timbers or pilings used to support railroad trestles or the former elevated roadway (Alaskan Way S.). In general, PAHs are relatively insoluble in water and bind to soil particles. Consequently, although some of these compounds are extremely toxic to humans, they are relatively immobile.
- **Metals.** Heavy metals, including arsenic, cadmium, chromium, lead, zinc, and copper, are associated with metal works, foundries, and plating operations. Metal-contaminated sites have the greatest effect on the soils and groundwater directly underlying the site; however, metals may also move off site with groundwater. Because of the limited mobility of metals, downgradient soils are not likely to be highly contaminated as a result of groundwater migration.
- **Halogenated solvents.** Trichloroethylene and tetrachloroethylene were used historically as solvents in dry-cleaning operations and for degreasing in a variety of businesses. These compounds result in breakdown products such as dichloroethylene and vinyl chloride. A variety of businesses such as machine shops and metal works tended to use small volumes of solvents. Solvents are highly toxic at low concentrations and are highly mobile in soil and groundwater. Most solvents are denser than water; therefore; they tend to move downward through the subsurface and water column. Unlike most contaminants, solvents can migrate relatively readily through fine-grained soils.
- **PCBs.** The most likely sources of PCBs are spills or leaks of dielectric fluids from PCB-containing equipment such as transformers or switches, which are often found at power stations. PCBs are associated with junkyards because of the historical mismanagement of used electrical equipment. PCBs tend to adhere to organic matter in soil and do not readily migrate from soil to groundwater.

Elevated pH is also potentially toxic in aquatic environments. Surface water that contacts high pH material may also develop high pH levels. When discharged to a body of water, the affected surface water may adversely affect organisms in the aquatic environment. Elevated pH may occur naturally in soils or result from artificial material such as new concrete. As discussed in Section 4.2, elevated pH has been encountered frequently in fill in the south end of the study area and in native soil along the central section. Surface water that contacts the elevated pH material may need to be neutralized before it can be discharged.

Large quantities of fill and wood have also been encountered in the south section of the study area, and the presence of these materials may affect disposal options. Fill materials were placed in the tidelands in the 1910s to 1920s around pile-supported railroad lines and around a parallel, wood-planked timber trestle roadway that extended along the waterfront to Smith Cove. Reportedly, many of the piles were treated with creosote (composed of PAHs and petroleum compounds). Because of the toxic constituents of creosote, these treated timbers pose a hazard to human health and the environment, both from the timbers themselves and from contamination that has leached from the wood to the adjoining soil and groundwater. The timbers appear to be closely spaced, and they would complicate the excavation, handling, and disposal of fill materials. In addition to the creosote and timbers, the fill materials likely contain a variety of other contaminants. Petroleum hydrocarbons are relatively common contaminants in the fill materials. Metals, construction debris, and other constituents are also likely to be present in the fill.

The decay of wood and sawdust, which was used as fill at the south end of the study area, can result in the production of methane and H_2S. Methane is a flammable gas that can explode under certain conditions. H_2S poses problems for workers because it is denser than air and sinks in trenches, displacing air. In addition, H_2S can dissolve in water. King County Metro has established discharge criteria for H_2S in the municipal sewer system.

4.3.2 Major Cuts and Fills in the Study Areas

During the last hundred years or so, fill material was placed to depths of 5 to 50 feet along East Marginal Way S. and the Port of Seattle facilities. Much of the shallow soil in the south area and along the waterfront was dredged from the Duwamish Waterway and hydraulically placed (placed with the use of water). A variety of pile-supported structures, dock facilities, and railroad tracks were formerly located along the south area. Concrete, wood, human-generated debris, ship ballast, sawmill by-products, trees, and other waste and debris are likely to be present in the fill. Piles from former structures and railroad alignments were likely left in place and are now buried (NWAA/EHC 2006). Multiple structures and multiple reconstructions and realignments of railroad tracks likely occurred.

A large number of piles, some closely spaced, may be present. Abandoned piles, trees, and other wood that has been continuously saturated and buried may be in relatively sound condition.

Front Street, now known as First Avenue, was located adjacent to the original shoreline of Elliott Bay. By 1885, the City had created a 120-foot railroad right-of-way 60 feet offshore, extending from S. King Street to Smith Cove (Hershman et al. 1981). The original Seattle waterfront from S. King Street to Union Street was destroyed in the Great Seattle Fire of 1889, which consumed 30 city blocks (Hershman et al. 1981). When the area was rebuilt, piles were used to support piers, and the railroad trestles and timber walkways provided access from the piers to land. Many of the piles were likely treated with creosote (*Seattle Daily Times* 1903). The area between the end of the piers and the land was gradually filled with soil, wood waste, ship ballast, and various other types of refuse, including burned waste from the fire.

The present shoreline between S. Washington Street and Madison Street was established between 1901 and 1917 using a pile-supported gravity seawall. Railroad Avenue was backfilled with material from the regrading of S. Jackson Street. The remainder of the City's seawall improvements were not finished until 1934 (Bjorke 1934). As part of the construction of the seawall north of Madison Street, Railroad Avenue was filled and converted from a wood-planked roadway to a paved thoroughfare. The construction of the Alaskan Way Viaduct was completed in 1953, at which time several railroad tracks in this area were removed. Trolley tracks currently lie between the Alaskan Way surface street and the Alaskan Way Viaduct (Hershman et al. 1981). The proposed alignments for the Elevated Structure and the Cut-and-Cover Tunnel Alternatives in this area are located between the Elliott Bay Seawall and the Alaskan Way Viaduct. The area was initially developed using wood-planked trestles for Railroad Avenue (now Alaskan Way) and the railroad lines (Hershman et al. 1981). The nearest land-based businesses were located between the eastern edge of the railroad tracks and Western Avenue. These buildings were most likely supported on piles.

By the late 1800s, S. King Street terminated at a coal wharf, which also housed machine shops and a roundhouse for railcars (Dorpat 1984). Metal works, metal-plating shops, machine shops, and foundries were located on wharves both north and south of the S. King Street Wharf throughout the early 1900s.

Transit sheds for a variety of goods, including coal, grain, fish, and dry goods, were located on the piers. Terminal 46, located adjacent to the proposed alignments, is used as a container transfer facility for the Port of Seattle.

The commercial district around Pioneer Square was initially developed in 1885. Within a year of the 1889 fire, the area was rebuilt. Many of these buildings were constructed of brick, and they housed retail/commercial businesses, offices, and hotels (NWAA/EHC 2006). Scattered throughout this section of Seattle were numerous dry cleaners, laundries, print shops, and gas stations. Although several dry cleaners remain, many of the gas stations have been closed. Retail, office, and small commercial businesses dominate this section of Seattle. The historic Pioneer Square area has undergone little redevelopment. Redevelopment has occurred along First Avenue, although newer construction is interspersed with many buildings constructed in the 1920s and 1930s. In addition, some sites have been converted to parking lots.

The southern portion of Denny Hill was regraded between 1903 and 1908, allowing for the expansion of commercial activities. By the 1930s, gas stations/ repair shops also occupied this area.

As described above, tetrachloroethylene, a solvent used in dry cleaning and metal degreasing, has been detected in soil and perched groundwater at the Vagabond Inn site (currently Seattle Pacific Hotel). The parcel is located adjacent to the proposed tunnel operations building at the north portal for the Bored Tunnel Alternative, and within the project footprint for the Elevated Structure and Cut-and-Cover Tunnel Alternatives. A tetrachloroethylene release at the Vagabond Inn site has been reported to Ecology, but no cleanup has been documented.

The north area currently has a mixture of commercial/retail and residential uses. Most of the gas stations and dry cleaners are no longer operating; however, many of the sites that were once used for these purposes have been converted to surface parking. Redevelopment has occurred throughout this area. New condominiums, some with retail space on the ground floors, have been constructed in the Belltown district.

City combined sewer outfalls are located along the waterfront at S. Washington Street, Madison Street, University Street, and Vine Street. King County combined sewer outfalls are located at S. Lander Street, S. Royal Brougham Way, S. King Street, and Denny Way. City storm drains are located at S. Spokane Street, S. Hinds Street, S. Washington Street, Seneca Street, and Pine Street. There is also a permitted discharge of backwash water from the Western Avenue steam plant's water treatment system to Elliott Bay (Aura Nova Consultants, Inc. Contractor Team 1995). Elevated concentrations of highly mobile contaminants, particularly gasoline and solvents, may be present in the permeable backfill of the sewer system. In addition, metals and poorly soluble organics may be present in sediment near the outfalls.

H_2S is locally present in the subsurface, either as the result of a contaminant release or as a natural by-product of the breakdown of organic matter under oxygen-reducing conditions. H_2S can dissolve in groundwater at concentrations exceeding King County Metro's discharge criterion, necessitating treatment before discharge. At this concentration, H_2S also poses a potential hazard to site workers. At low concentrations, H_2S presents a nuisance odor. Although H_2S could result from wood and sawdust decay anywhere along the waterfront, to date it has been encountered only at the waterfront at the end of University Street, directly south of a Bunker C fuel release from the site owned by Puget Sound Power and Light. Since Bunker C fuel can contain high concentrations of sulfur compounds, this appears to be the most likely source of the H_2S; however, it could be associated with a sewer release.

4.4 Validated Sites

Validated sites are sites of concern that in addition to posing a risk to the environment also would potentially adversely affect the project. Sites of concern were identified from two primary sources, (1) historical land use records for businesses that may have used hazardous materials and (2) regulatory lists documenting contamination. No sites were identified based solely on environmental sampling conducted for the project; however, this information was used to characterize soil and groundwater in the project area.

Proximity of the validated site to the alignment influences the level of risk to the project. Sites adjacent to the right-of-way have a greater potential for adverse effects than sites that are farther away. For the Bored Tunnel Alternative, sites of concern that directly overlie the bored tunnel where the tunnel crown would be less than 100 feet bgs could have a potential impact on the project. Sites adjacent to the right-of-way may adversely affect the project by off-site migration of contaminants, particularly via shallow utilities that may affect surface elements of the build alternatives, and by the vertical migration of solvents that may contaminate soil in the bored tunnel section of the project area. The potential risks posed by the sites have been characterized as low, moderate, or high, for each build alternative depending on the type of contaminant, whether the contamination is documented, and whether the site would be acquired for the particular alternative.

The distribution of validated sites by alternative and area is provided in Exhibit 4-14. The validated sites are identified by site number, type of business or historical land use, and parcel number in Attachment G. The site location relative to the alternative alignment, the sources of information on historical land use, a description of the documented or potential contamination, the planned construction, and the potential impact and rationale for the determination are also summarized. All sites within the study areas that pose a risk to the environment but may not necessarily affect the build alternatives are described in Attachment D.

Exhibit 4-14. Summary of Validated Sites

Area	Elevated Structure Alternative			Cut-and-Cover Tunnel Alternative			Bored Tunnel Alternative		
	Low Potential Impact	Moderate Potential Impact	High Potential Impact	Low Potential Impact	Moderate Potential Impact	High Potential Impact	Low Potential Impact	Moderate Potential Impact	High Potential Impact
South	49	2	0	43	8	0	37	9	0
Central	114	12	1	107	19	1	6	3	0
North	49	13	4	49	13	4	37	7	3
Totals	212	27	5	199	40	5	80	19	3
Alternative totals	244			244			102		

The subsurface in the south area and along the waterfront is characterized by up to 50 feet of fill. The fill comprises fine- to medium-grained sand containing wood debris, creosote-treated timbers, burned wood, and coal. The potential for contamination from the fill and long-term industrial use of the area, including railroad use, has resulted in sites with the potential for dispersal of low-level contamination, primarily lubricating oil, heavy oil, and PAHs, with localized areas of solvent contamination, elevated concentrations of metals, and fuel contamination. In addition, shallow groundwater (2 to 12 feet bgs) is likely to facilitate the dispersal of contaminants.

Chapter 5 OPERATIONAL EFFECTS, MITIGATION, AND BENEFITS

Operational effects are those that occur over the long term once the facility is in use. This chapter discusses different types of operational effects, mitigation, and benefits potentially resulting from the Viaduct Closed (No Build Alternative) and the build alternatives. No operational effects were identified for the build alternatives that could not be mitigated through proper design, construction, and management.

5.1 Operational Effects of the Viaduct Closed (No Build Alternative)

Both federal and Washington State environmental regulations require agencies to evaluate a No Build Alternative to provide baseline information about existing conditions in the project area. For this project, the No Build Alternative is not a viable alternative because the existing viaduct is vulnerable to earthquakes and structural failure due to ongoing deterioration. Multiple studies of the viaduct's current structural conditions, including its foundations in liquefiable soils, have determined that retrofitting or rebuilding the existing viaduct is not a reasonable alternative. At some point in the future, the roadway will need to be closed.

The Viaduct Closed (No Build Alternative) describes what would happen if the Bored Tunnel Alternative or another build alternative is not implemented. If the existing viaduct is not replaced, it will be closed, but it is unknown when that would happen. However, it is highly unlikely the existing structure could still be in use in 2030.

The Viaduct Closed (No Build Alternative) describes the consequences of suddenly losing the function of SR 99 along the central waterfront based on the two scenarios described below. All vehicles that would have used SR 99 would either navigate the Seattle surface streets to their final destination or connect with I-5 via S. Royal Brougham Way. The consequences would last until transportation and other agencies could develop and implement a new, permanent solution. The planning and development of the new solution would have its own environmental review.

Under Scenario 1, there would be a sudden, unplanned closure of SR 99 between S. King Street and Denny Way due to some structural deficiency, weakness, or smaller earthquake event. Under this scenario, SR 99 would be closed for an unknown period until a viaduct replacement could be built. Severe travel delays and congestion would be experienced, and utilities on and underneath the viaduct would likely be damaged and would require repair or replacement.

Scenario 2 considers the effects of a catastrophic failure and collapse of SR 99. Under this scenario, a seismic event of similar or greater magnitude than the 2001 Nisqually earthquake could trigger failure of portions of the viaduct. This scenario would have a greater effect on people and the environment. Failure of the viaduct could cause injuries and death to people traveling on or near the structure at the time of the seismic event. This type of event could cause buildings to be damaged or collapse and cause extensive damage to utilities. Travel delays would be severe. The environmental effects and length of time it would take to repair the SR 99 corridor are unknown, but the effects would be substantial.

During a seismic event, the soil along the existing viaduct would likely liquefy, causing a substantial reduction in soil strength. In addition, the existing Elliott Bay Seawall would likely fail. The combination of weak soil and seawall collapse could lead to the collapse of the viaduct. If LBP is present in the viaduct, this material could become airborne. If the seawall collapses, contaminated surface and subsurface soil near the seawall would be mobilized. In addition, shallow sediment in Elliott Bay would be disturbed, and the water column would potentially be exposed to contaminated subsurface sediment (EPA 1988).

The operational effects related to hazardous materials are associated primarily with stormwater quality. Most of the stormwater runoff from the study area currently discharges to the combined sewer system. The pipes are owned and maintained by private entities, King County, or SPU. The stormwater system is discussed in Appendix O, Surface Water Discipline Report.

Other operational effects would include potential catastrophic spills of hazardous material or wastes resulting from vehicle accidents. To alert spill responders, hazard identification codes must be displayed on all vehicles transporting pressurized, flammable, oxidizing, toxic, radioactive, and/or corrosive materials. A hazardous material spill or a fire from a vehicle accident could result in hazardous conditions within the study area, specifically the following:

- The atmosphere could become toxic with chemical fumes or smoke
- The spill or fire could result in physical hazards for people
- Emergency response vehicles could have limited access

Contaminants that are released to the ground surface could migrate to unpaved areas where subsurface utility corridors and the surrounding coarse backfill could act as preferential pathways for contaminant migration. Contaminants may travel along utility corridors as dissolved compounds in shallow groundwater or as free product. Appropriate institutional measures would be necessary for ongoing control of accidentally released contaminants to avoid the creation of preferential pathways.

5.2 Bored Tunnel Alternative

The Bored Tunnel Alternative includes a 1.76-mile-long bored tunnel through downtown Seattle and the south and north areas. The southern limit of the project area is S. Royal Brougham Way, and the northern limit is Roy Street. After the tunnel and portal areas are constructed and traffic has been rerouted onto the new SR 99 alignment, the existing Alaskan Way Viaduct structure would be removed.

5.2.1 Operational Effects

Compared with the existing conditions, the Bored Tunnel Alternative would maintain or reduce pollutant loading and could improve the quality of stormwater runoff discharged from the study area to surface water. Under the Bored Tunnel Alternative, surface street improvements would include stormwater flow control and water quality treatment measures in compliance with Seattle's drainage code. Surface water in the tunnel would be discharged to the combined sewer system. A discussion of stormwater treatment is provided in Appendix O, Surface Water Discipline Report.

A risk associated with an indirect effect of the Bored Tunnel Alternative (and most transportation facilities) would be the potential for catastrophic spills of hazardous materials or wastes resulting from vehicle accidents once the roadway is operational. The environmental impacts may be less harmful in a tunnel because the spill would be contained. However, the potential threat to the health and safety of responders and vehicle occupants would be greater under the Bored Tunnel Alternative than under the Viaduct Closed (No Build Alternative) because the Bored Tunnel Alternative would result in enclosed space with limited access and egress.

The bored tunnel would be closed to all placarded vehicles transporting potentially hazardous cargo. This includes all vehicles carrying explosives, flammable substances, nonflammable gas, dangerous materials, oxidizer materials, corrosive materials, and poisonous and radioactive materials. These materials are currently prohibited in the Battery Street Tunnel; therefore, all these materials would continue to be transported via the hazardous materials detour routes in Seattle.

Coarse backfill surrounding utilities can provide a preferential pathway for contaminant migration. Infiltrating water can travel laterally in the backfill, dispersing contaminants. Under the Bored Tunnel Alternative, subsurface utilities would be surrounded by coarse backfill, resulting in subsurface conditions that would be similar to existing conditions.

Groundwater in the study area may be locally contaminated. The water table in the south area is about 2 to 12 feet bgs. The depth to water increases in the north because of the rise in the ground surface elevation. Since the Seattle Municipal Code prohibits the use of groundwater as a source of potable water, risk to humans through direct consumption is minimal. Therefore, the greatest threat posed by contaminated groundwater is to the receiving surface water bodies: Elliott Bay, Lake Union, and Puget Sound.

Groundwater flow and, therefore, groundwater contaminant distribution could be altered by the presence of the walls supporting the retained cuts, cut-and-cover tunnels, and ground improvement areas. The retaining walls would extend about 500 feet south of the south portal and would essentially block the natural direction of groundwater flow, which could result in a localized higher groundwater level as groundwater backs up against the wall. In particular, groundwater mounding could occur along the east side of the walls, because groundwater flow is generally toward Elliott Bay. Groundwater mounding could also occur along Alaskan Way, where ground improvement may be necessary. The localized increases in water levels are expected to be within the normal range of water table fluctuation.

A barrier to groundwater flow, such as the tunnel wall or a ground improvement zone, would hinder contaminant migration to the receiving water by increasing the travel distance. Contaminants would take longer to migrate because they would have to move laterally along the barrier wall before a break or window in the wall would allow groundwater movement toward the receiving water. However, a longer travel path would have little effect on the amount of contaminants that ultimately reach Elliott Bay.

The Bored Tunnel Alternative could be identified as a contributor to contaminant migration because before project construction, only downgradient properties would have been affected. With lateral movement of groundwater, adjacent properties that were previously crossgradient from a contaminant migration pathway could be affected. In addition, this alternative could be identified as a contributor if the elevation of contaminated groundwater rises and penetrates a basement or subsurface vault. However, the water level increase is expected to be within the normal range of groundwater level fluctuations. If the groundwater is contaminated, the water could require treatment before disposal; this effect is evaluated primarily in Appendix P, Earth Discipline Report, which discusses groundwater.

Subsurface structures installed in areas of contamination may be vulnerable to degraded indoor air quality. Volatile compounds, including gasoline, benzene, and chlorinated solvents, all of which have been detected along the alternative alignment, could infiltrate basements or underground vaults. The potential for vapor intrusion is primarily a function of the vapor pressure and the concentration of a contaminant. It is also location specific, because the ability for vapor to migrate in soil depends on such factors as soil permeability and porosity, carbon content, soil moisture, and depth to groundwater. Vapor intrusion has not been identified along the alignment. Air quality is discussed in Appendix M, Air Discipline Report.

5.2.2 Viaduct Removal

The Bored Tunnel Alternative includes relocating the utilities on and beneath the existing viaduct and demolishing the existing viaduct. Demolition of the viaduct would have some operational benefits related to hazardous materials. Due to a decrease in pollutant-generating impervious surface (PGIS) resulting from the Bored Tunnel Alternative, pollutant loading would decrease relative to existing conditions. A benefit of the viaduct removal would be that once it has been removed, soil liquefaction and potential seawall failure could not cause its collapse and a resultant airborne release of hazardous materials.

5.2.3 Battery Street Tunnel Decommissioning

The Bored Tunnel Alternative includes decommissioning the Battery Street Tunnel. As part of the decommissioning process, proper management and disposal of ACM and LBP that are present in concentrations exceeding the criteria would be required. Once the tunnel has been decommissioned, hazardous materials that are present in the tunnel would be removed. There are no operational effects related to decommissioning the tunnel.

In one study, samples of the soot that lines the tunnel were found to contain contaminant concentrations that exceeded the MTCA Method A cleanup levels and lead concentrations that were greater than the dangerous waste criterion. The concentration of cadmium also exceeded the dangerous waste criterion in one sample (Taylor 2007). In another study of the tunnel conducted in 2008 (Pacific Rim Environmental 2008), ACM, lead, and mercury were identified. The conduit contains asbestos, and the fire doors are presumed to contain asbestos. During the 2008 study of the tunnel, LBP was identified on painted fire doors, fire cabinets, and the yellow stripe painted along the barrier between the northbound and southbound lanes. Low levels of mercury were found in lights, and their disposal would need to be managed under the universal waste rule.

The tunnel could be filled with debris generated from the viaduct removal. Appropriate management and handling of demolition material from the viaduct would be performed to address the specific environmental hazards associated with concrete rubble, including high pH. In addition, necessary regulatory permits and approvals would be procured if they are determined to be necessary to perform this type of construction activity.

5.2.4 Mitigation

Under the Bored Tunnel Alternative, the tunnel roadway would not be exposed; therefore, once the viaduct is demolished, the impervious surface area would be reduced relative to that of the Viaduct Closed (No Build Alternative) or the other build alternatives. In addition, stormwater that comes in contact with PGIS would comply with the flow control and water-quality treatment requirements specified in Seattle's drainage code, or it would be discharged to the sanitary sewer.

The Seattle Fire Department emergency response crews are equipped to handle small spills and fires. If a large release occurs, the national spill hotline can be contacted to mobilize more resources. Prompt response reduces the potential for hazardous materials to disperse into the environment and injure the public. Appropriate institutional measures would be necessary for ongoing control of accidentally released contaminants to avoid the creation of preferential pathways.

To mitigate the potential development of preferential pathways in utility corridors, CDF or trench dams could be installed. The dams could be installed at intervals along utility runs where contamination is suspected, preventing the migration of contaminants in shallow groundwater.

Groundwater monitoring devices have been installed in the Program area to evaluate the groundwater levels over time. Groundwater samples have been collected to assess water quality. Additional groundwater monitoring could be conducted if contaminated groundwater is expected.

Groundwater mounding would be evaluated for all walls and ground improvement zones longer than about 100 feet, where groundwater could build up against the wall. If the magnitude of the groundwater mounding would be less than the current measured natural fluctuation of groundwater in the soil, then no mitigation measures would be necessary because the Bored Tunnel Alternative would not substantially alter the groundwater flow. If greater mounding is expected, mitigation measures could consist of providing a path for groundwater through the retaining walls or ground improvement zones. This could be achieved by constructing pipes or drainage trenches that connect the groundwater flow between the west and east sides of the wall. Before pipes or drainage trenches are installed, groundwater quality could be evaluated, and the placement of the pipes or trenches could be modified to reduce the change in groundwater flow and existing contaminated groundwater conditions.

Mitigation measures for potential vapor intrusion could include removing the nearby contaminated soil and/or groundwater in areas where a basement or subsurface vault would be installed. Vapor barriers could be installed during construction of the subsurface structure. Vapor barriers could also be installed from within the structure, if the conditions change. Engineering controls such as fans may also be effective in dissipating vapors. Construction of the bored tunnel is unlikely to adversely affect areas where vapor intrusion may currently be a problem.

5.2.5 Benefits

A potential benefit of the Bored Tunnel Alternative would be the removal of contaminated soil that may be present along the alignment, particularly at the south and north portals. Although many of the contaminants identified near the south portal (creosote, lubricating oil, heavy-oil, and metals) are not highly soluble, the removal of contaminated soil would reduce future groundwater contamination in the area, if present, and could reduce the potential exposure of workers who participate in future excavation projects in the area.

Ground improvement, such as soil mixing and jet grouting, and the construction of diaphragm walls in the south area and at the south end of the bored tunnel are expected to limit the mobility of contaminants in soil and their potential to migrate with groundwater.

5.3 Cut-and-Cover Tunnel Alternative

The project area for the Cut-and-Cover Tunnel Alternative extends northward along the downtown Seattle waterfront from approximately S. Royal Brougham Way. At Battery Street, the alignment turns northeast and extends to approximately Aloha Street along the existing SR 99 alignment. The seawall replacement extends from approximately S. Jackson Street to approximately Broad Street along the waterfront.

5.3.1 Operational Effects

The operational effects of the Cut-and-Cover Tunnel Alternative are expected to be similar to those of the Bored Tunnel Alternative. This alternative includes implementing stormwater flow control and water-quality treatment measures to comply with Seattle's drainage code. Pollutant loading would decrease relative to existing conditions, primarily due to a decrease in PGIS. In addition, due to stormwater treatment, stormwater quality would be improved compared to existing conditions and conditions resulting from the Viaduct Closed (No Build Alternative).

Potential hazardous conditions due to a catastrophic spill could occur within the cut-and-cover tunnel or the Battery Street Tunnel, which would be seismically and structurally retrofitted as part of this alternative. Placarded vehicles are currently prohibited from the Battery Street Tunnel. Under the Cut-and-Cover Tunnel Alternative, they would continue to be prohibited from the Battery Street

Tunnel, and from the cut-and-cover tunnel as well. Utility corridors could act as preferential pathways for contaminant migration with any build alternative, as they do currently.

The cut-and-cover tunnel and the rebuilt section of the Elliott Bay Seawall would act as a barrier to groundwater flow to a greater extent than under the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative, because a larger area would have ground improvement that results in reduced permeability. Groundwater would flow around the end of the seawall before discharging to Elliott Bay. Contaminants present in the groundwater would follow that pathway and could result in widespread soil and groundwater contamination.

Similar to the Bored Tunnel Alternative, subsurface structures installed in areas of contamination may be vulnerable to degraded indoor air quality. However, extensive ground improvement and the construction of diaphragm walls would occur along the waterfront and in the south area for this alternative. These construction methods fill voids in the subsurface and would effectively restrict vapor transport. In addition to the cut-and-cover tunnel, subsurface vaults or basements would be installed or modified as part of life and safety improvements for the Battery Street Tunnel. Vapor intrusion has not been identified as an existing problem along the alignment. Air quality is discussed in Appendix M, Air Discipline Report.

The Cut-and-Cover Tunnel Alternative includes relocating the utilities on the existing viaduct and demolishing the existing viaduct. Demolition of the viaduct would have some operational benefits related to hazardous materials. Due to a decrease in PGIS, pollutant loading would decrease relative to existing conditions. A benefit of the viaduct removal would be that once it has been removed, soil liquefaction and potential seawall failure could not cause its collapse and a resultant airborne release of hazardous materials.

5.3.2 Mitigation

The potential mitigation measures for the Cut-and-Cover Tunnel Alternative are similar to the measures that could be implemented for the Bored Tunnel Alternative, which are discussed in Section 5.2.4.

5.3.3 Benefits

A potential benefit of the Cut-and-Cover Tunnel Alternative is the large-scale removal of contaminated soil that may be present along the alignment. Although many of the contaminants identified along the waterfront (creosote, lubricating oil, heavy oil, and metals) are not highly soluble, removal of contaminated soil would reduce future groundwater contamination in the area, if present. In addition, most of the utilities would be installed above the cut-and-cover tunnel in areas of clean backfill. Therefore, workers servicing the utilities would not be exposed to contaminated soil and airborne contaminants from the contaminated soil. Compared to the Bored Tunnel Alternative, substantially more contaminated soil would be removed for the Cut-and-Cover Tunnel Alternative.

Ground improvement that is required for the seawall north of the cut-and-cover tunnel is expected to reduce the mobility of contaminants in soil and their potential to migrate with groundwater.

5.4 Elevated Structure Alternative

5.4.1 Operational Effects

The operation effects and benefits of the Elevated Structure Alternative have many similarities to those of the Cut-and-Cover Tunnel Alternative and the Bored Tunnel Alternative. Coarse backfill associated with utilities could provide preferential pathways for contaminant migration, as described in Section 5.2.1. The PGIS is assumed to be similar to that of the existing viaduct, and stormwater contacting the surface would require treatment before discharge. In addition, the rebuilt Elliott Bay Seawall would act as a barrier to groundwater flow similar to the cut-and-cover tunnel described above. The total length of the lower-permeability area along the waterfront is assumed to be similar to that of the Cut-and-Cover Tunnel Alternative, and less than that of the Bored Tunnel Alternative.

Similar to the tunnel alternatives, subsurface structures installed along the Battery Street Tunnel in areas of contamination may be vulnerable to degraded indoor air quality. However, this alternative requires very few subsurface basements or vaults. They would be installed or modified as part of the fire and safety improvements for the Battery Street Tunnel. Vapor intrusion has not been identified as a problem near the tunnel.

Potential impacts from a hazardous material spill and/or fire on an elevated structure would be less than the impacts resulting from similar incidents that occur under either of the tunnel alternatives because this alternative would result in substantially less enclosed space. Please see Appendix O, Surface Water Discipline Report, for a discussion of stormwater treatment and Section 5.2 of this report for additional discussion of operational effects and benefits.

The Elevated Structure Alternative includes relocating the utilities on the existing viaduct and demolishing the existing viaduct. Demolition of the viaduct would have no operational effects related to hazardous materials, as described for the Bored Tunnel Alternative.

5.4.2 Mitigation

Potential mitigation measures for the Elevated Structure Alternative are similar to the measures that could be implemented for the other two build alternatives, which are discussed in Section 5.2.4.

5.4.3 Benefits

Although some contaminated soil would be removed during construction associated with the Elevated Structure Alternative, the soil volume and overall benefit would be smaller in comparison to either of the tunnel alternatives. However, the ground improvement associated with the Elevated Structure Alternative is expected to reduce the mobility of contaminants in soil and their potential to migrate with groundwater.

Removal of contaminated soil primarily associated with drilled shafts and utilities would reduce future groundwater contamination in the area, if present, and could reduce the potential exposure of workers who participate in future excavation projects in the area.

Chapter 6 Construction Effects and Mitigation

Construction effects could arise if contaminated soil or groundwater is encountered during the utility relocations; the construction of the bored tunnel, cut-and-cover tunnel, retained cuts, retaining walls, and building foundations; or the implementation of ground improvement. Construction effects would likely occur where these construction activities are required on validated sites that have been identified as potentially contaminated based on the evaluation discussed in Chapter 4. In addition to evaluating the potential effects of the validated sites, this chapter discusses how construction activities involving hazardous materials could adversely affect the environment. No validated sites or construction activities would present a significant unavoidable adverse impact that could not be mitigated.

6.1 Construction Effects Common to All Alternatives

Construction activities would result in several types of effects related to hazardous materials:

- Spoils containing contaminated soil and debris would be removed from the subsurface.
- Construction would involve the removal of spoils with an elevated pH, including excavated soil with naturally occurring elevated pH levels, the removal of spoils from the bored tunnel that contain additives, and the handling of grout waste with cement content.
- Contaminated groundwater would be extracted during dewatering near the retained cuts, cut-and-cover tunnels, and foundations.
- Groundwater pathways could be modified by subsurface construction, resulting in the potential spread of existing contaminants.
- Air quality could be affected by the release of contaminants and dust during construction and handling of contaminated media.

Standard impacts that routinely apply to hazardous material in WSDOT construction projects are shown in Attachment J, Exhibit J-1. These impacts relate to contaminated soil and groundwater, USTs, spills, demolition, worker safety, and public health. Standard impacts and mitigation measures typically apply to low or moderate risk sites with straightforward mitigation measures that can be reasonably predicted based on experience.

All the build alternatives share many common construction elements. The degree to which the construction method is implemented would vary for each alternative. A general description of the construction elements used by all of the build alternatives and the potential effects is provided below. The description of each alternative includes construction elements and methods.

Construction methods that would involve direct soil removal include excavation for retaining walls, changes in grade, underground utilities, and cut-and-cover tunnels. Similarly, the use of drilled shafts for the construction of piles and diaphragm walls would result in large volumes of spoils that would require handling and proper disposal.

Ground improvement techniques used for all of the build alternatives (jet grouting, DSM, and compensation grouting) would also generate large volumes of spoils and groundwater. Jet grouting operations, which involves the injection of cement grout to strengthen the subsurface soils, typically produce spoil volumes equal to about 50 to 70 percent of the volume of treated soil. This spoil material would consist of a blend of eroded soil and cement grout that is flushed to the ground surface during grouting. An estimated 20 percent of these spoils would be solids.

DSM, which involves in situ mechanical mixing of soil and cement, would produce spoil volumes equal to about 30 to 50 percent of the DSM column area (the columns typically constitute about 30 percent of the total treated area). The spoils from DSM would consist of blended soil and cement with the consistency of thick mud. Compensation grouting is a variation of DSM that is used to prevent ground loss during tunneling.

Spoils from jet grouting, compensation grouting, and DSM are comingled with cement and would likely have elevated high pH (>8.5). The spoils would require containment for at least 24 to 48 hours to allow them to stabilize before their transport to a disposal area. If excess water is present, it would likely have a high pH, necessitating its treatment before disposal.

6.2 Construction Effects of Bored Tunnel Alternative

6.2.1 South Area

All of the build alternatives follow a similar alignment from S. Royal Brougham north to S. Dearborn Street. Under the Bored Tunnel Alternative, the main roadway would begin at-grade near S. Royal Brougham Way and transition into a retained cut. On- and off-ramps would also be built in retained cuts on either side of the main roadway. The roadway would continue as a cut-and-cover tunnel, becoming a double-level roadway at the south portal of the bored tunnel, near the intersection of Alaskan Way S. and S. Dearborn Street. At the south tunnel portal, the TBM launch pit would require a retained excavation measuring about 70 feet wide and 95 feet deep. The south area would also include a tunnel operations building.

Retaining wall types that could be used in the south area for shallower excavations include soldier pile and lagging walls, sheet pile walls, cantilevered cast-in-place concrete walls, and diaphragm walls. Diaphragm walls would likely be used to support the sides of cuts deeper than about 15 feet bgs, including the cut-and-cover tunnel, and the excavation for the tunnel operations building. The advantage of diaphragm walls is that they can be used as temporary excavation support as well as the permanent retaining wall for the final structure. Types of diaphragm wall include DSM walls, slurry walls, secant pile walls, and tangent pile walls. In addition to supporting excavation sidewalls, diaphragm walls are relatively impermeable (to prevent the passage of water), thereby reducing groundwater flow into the excavations. After installation of the diaphragm walls, areas between or adjacent to these walls would be excavated, and the diaphragm wall would serve as the retaining wall for the excavation.

Ground improvement may be performed beneath or around foundations and/or the retained cuts and cut-and-cover tunnel sections (to be built in the portal areas for the bored tunnel) to stabilize soft soils, reduce groundwater inflow, and/or mitigate potential liquefaction. Ground improvement could consist of DSM or jet grouting. The construction effects of ground improvement are described in Section 6.1.

During installation of drilled shafts and/or cast-in-place piles, shallow groundwater and/or water used to stabilize the hole during drilling would be displaced to the ground surface. This water may have a pH greater than 10 because of its contact with the grout. Water with a pH greater than 10 would require treatment before discharge. At a pH of 12, the liquid would be considered a dangerous waste. Fines (cement) may also be suspended in the water. Locally, the groundwater could also be contaminated as a result of historical activities.

In the south area, the Bored Tunnel Alternative also includes the construction of new surface streets over the cut-and-cover tunnel of the new SR 99 roadway between S. Royal Brougham Way and S. Dearborn Street. These streets would be constructed at-grade. Several fills may be constructed to connect the SR 99 roadway to the new mainline elevated structure south of S. Royal Brougham Way and within the cut-and-cover section above the finished roadway structures.

Contaminated Spoils

Direct soil removal in the south area would include excavation for retained cuts, retaining walls, changes in grade, and utilities. Similarly, the use of drilled shafts for the construction of diaphragm walls would result in large volumes of spoils that would require treatment and proper disposal. Ground improvement techniques used in construction would also generate large volumes of spoils, as described in Section 6.1.

For the south area, the estimated volume of material that would be excavated or generated as spoils is 284,500 cy (Exhibit 6-1). This estimate is based on the conceptual drawings for the Bored Tunnel Alternative dated August 2010 and revised in January 2011 with updated concepts from the design builder. An estimated 73 percent of the excavated material (208,500 cy) may be considered potentially contaminated and may require special handling. These volumes are based on design parameters and are estimated to be within 30 percent of the actual volumes. As shown in the profile view of the proposed excavation and the major soil units, the fill layer extends to a depth of approximately 20 to 30 feet bgs in the south area (Exhibit 4-1). The actual quantities may be less than these estimates.

Fill in the south area consists of soil and debris from unknown sources. Construction throughout this area could encounter contaminants such as petroleum, metals, and PAHs in the fill soils, as well as creosote-treated timbers and wood debris. Coal in the fill that originated from the S. King Street coal pier would yield PAHs. As described in Section 4.2, low concentrations of petroleum and other contaminants have been detected in this area; however, the contaminant concentrations appear to be less than the dangerous waste criteria but sometimes greater than the MTCA Method A cleanup levels. In addition to being contaminated, the fill soil would not be suitable for reuse as structural fill unless it is screened to remove the comingled wood debris. The soil removed from the south area may be segregated into four categories for disposal.

1. **Clean soil**: Soil containing no detectable petroleum hydrocarbons, VOCs, PAHs, or PCBs, and no metals at concentrations that exceed the MTCA Method A cleanup level, or a pH below 6.5 or above 8.5. Disposal or reuse of soil would also require compliance with county or city requirements that may restrict their placement.

2. **Class II impacted soil**: Soil containing detectable concentrations of petroleum hydrocarbons, VOCs, PCBs, PAHs, and/or metals that are less than the MTCA Method A cleanup levels, or a pH below 6.5 or above 8.5. This category includes a wide range of contaminants; acceptance of this material is facility specific.

3. **Problem waste**: Soil containing one or more contaminant(s) at concentrations that exceed the MTCA Method A cleanup levels and wood waste consisting of timbers, sawdust, or other abundant organic matter.

4. **Dangerous waste**: Waste for which a wide range of contaminant-specific, source-specific, and concentration-specific criteria are designated in WAC 173-303-070 through 173-303-100. For the project area, the most likely types of dangerous waste that could be encountered would be soil that

Exhibit 6-1. Estimated Excavation Quantities for Bored Tunnel Alternative

Area	Clear Existing Rail, Ballast, Ties, Obstructions (Demolition) [1] (cy)	Clear Existing Pavement, Structures, Obstructions [2] (cy)	Retained Cut (cy)	Cut-and-Cover Tunnel (cy)	Diaphragm Walls Excavation (cy)	Drilled Shafts (cy)	Deep Soil Mixing [3] (cy)	Jet Grouting[4] (cy)	Stone Columns (cy)	Site Excavation [5] (cy)	Structural Excavation[6] (cy)	Soil Boring for Tunnel [7] (cy)	Total Excavation (cy)
Total Excavation Quantities													
South	26,000	26,000	209,000				23,000		<500 [8]				**284,500**
Viaduct		107,000											**107,000**
Bored tunnel								49,000 [9]				900,000	**949,000**
North		88,000								145,000			**233,000**
Totals:		**221,000**	**209,000**				**23,000**	**49,000**	**<500**	**145,000**		**900,000**	**1,573,500**
Excavation Quantities - Potentially Contaminated or Requiring Special Handling and Disposal													
South	26,000	26,000	159,000				23,000		<500 [8]				**208,500**
Viaduct		107,000											**107,000**
Bored tunnel								49,000 [9]				900,000	**949,000**
North		88,000								72,500			**160,500**
Totals:		**221,000**	**159,000**				**23,000**	**49,000**	**<500**	**72,500**		**900,000**	**1,451,000**

Notes:

These estimates are based on the Bored Tunnel Alternative conceptual drawings dated August 2010 and revised in January 2011 with updated concepts from the design builder. For the purposes of these estimates, quantities have been calculated for the cut and fill items noted. Actual import and export quantities may be less than those indicated as portions of these materials may be stored on site and reused. The Battery Street Tunnel is included in the category "Viaduct."

An underlined value indicates that a portion of the excavation quantity does not require special handling and disposal (the volume is less than the total quantity volume).

cy = cubic yard

[1] Estimated quantity to clear existing waterfront trolley ballast and ties. Assumed depth is 2 feet, 6 inches.

[2] Estimated quantity to clear existing roadway pavement and miscellaneous structures. Assumed depth is 2.0 feet. Also includes construction debris from the viaduct demolition.

[3] Assumes ground improvement is equal to 35 percent of the total improved soil mass, and 30 percent of this volume is returned to the surface as soil-cement spoils.

[4] Estimated spoils generated by ground improvement and stabilizing measures.

[5] Estimated quantity of general site excavation, not otherwise classified.

[6] Estimated quantity of excavation for structures, abutments, large utility vaults, etc.

[7] Soil boring for tunnel assumes an additional 0.5 percent from soil loss and 0.5 percent of additives.

[8] Ground improvement that includes earthquake drains east of the deep soil mixing areas in the south area are expected to generate little to no spoils. An estimated 500 cy of spoils consisting of wood debris could be generated.

[9] Estimated spoils (49,000 cy) from jet grouting operations that overlap the Elliott Bay Seawall Project in the south. Spoil volume was calculated assuming 100 percent of the improved soil mass is covered, and 25 percent of this volume is returned to the surface as soil-cement spoils.

leaches lead at concentrations greater than 5 mg/L. Soil with concentrations exceeding the TCLP leaching criteria is identified as characteristic dangerous waste. Dangerous waste may also be associated with a particular operation such as dry cleaning, as described for the north area.

Confirmation sampling to support waste designations may be required by the disposal facility. Depending on the level of contamination (clean, low, or greater than the MTCA Method A cleanup levels), the spoils may be transported to a land reclamation facility or a RCRA Subtitle D landfill. Dangerous waste must be disposed of at a RCRA Subtitle C landfill.

Soil disposal options are discussed in Section 6.8.5. All of the material that would be removed for at-grade work is assumed to be contaminated or to require special handling. Included in the estimates of potentially contaminated excavation quantities (Exhibit 6-1) are all of the pavement, surface structures, and obstructions that would require special handling because of the brick and asphalt mixed with the concrete.

Handling and disposal of spoils generated during construction associated with the Bored Tunnel Alternative could result in significant adverse effects; however, these effects would be mitigated by the development and implementation of construction management plans. Mitigation would also include the establishment of a budget that reflects the costs associated with disposing of contaminated spoils and dewatering water. Early identification of contaminated soil and groundwater, and waste characterization, although increasing up-front costs, may minimize the volume of contaminated spoils. The construction methods could be modified to address contaminated media, and contaminated spoils could be segregated for appropriate disposal. Adequate laydown areas have been identified to allow sufficient stockpiling of soil without affecting the construction schedule. A maximum of 2,800 cy (4,000 to 5,000 tons) of soil per day could be excavated in the south area. Based on the engineering estimates, the laydown area(s) should be capable of storing approximately 25,000 cy of spoils, approximately 2 weeks' worth. If confirmation samples are not required, soil disposal would be more expedient.

Individual waste disposal companies operating in King County typically have the capacity to accept about 5,000 tons of material per day, assuming two shifts of work. If necessary, two or more waste disposal companies could be used for spoils disposal. Excavated fill, which is expected to be contaminated, could be hauled by truck to one of several staging areas identified in the south area or hauled directly to the disposal company's intermodal facility. Spoils could be routed to multiple facilities or temporarily stored until the facility's operations could accommodate them. The additional cost for stockpiling is estimated to be between $3.00 and $5.00/cy, excluding the cost of analytical testing. The material would then be transported by rail or barge to a facility permitted to accept it. Most of the native soils in the south area and bored tunnel section would likely not require disposal at a facility permitted to accept contaminated soil; however, elevated pH levels associated with the native soil and additive for tunnel boring may need to be neutralized before the spoils can be disposed of. These soils are expected to be otherwise clean, based on sampling that has occurred to date. Unit costs for disposal for the various classifications of waste are provided in Section 6.9.3. Handling and disposal options are indicated in the *Draft Spoils Handling and Disposal Planning Report* (PB 2009b).

Dewatering and Groundwater Contamination

As discussed in Appendix P, Earth Discipline Report, the water table in the south area is located about 2 to 12 feet bgs. Therefore, dewatering would be required during construction of the cut-and-cover tunnels and most of the retained cut sections. Dewatering would be accomplished by a series of dewatering wells installed within the construction area to be dewatered or depressurized. Recharge wells would also be installed to mitigate the lowering of the groundwater table that could cause settlement of adjacent structures.

Dewatering during construction could result in groundwater flow toward the excavated area. Consequently, subsurface contaminants, including total petroleum hydrocarbons, total suspended solids, and trace organics, could migrate toward the excavation from areas outside the alignment and increase pollutant concentrations in dewatering water (PB 2009b). Dewatering would likely continue until the construction of the retaining wall for the tunnel is completed, which is estimated to take approximately 9 months.

The adverse effects of dewatering in the south area could be mitigated by the development and implementation of construction management plans that describe the dewatering approach and discharge options. Discharge of dewatering water must comply with federal, state, and local regulations, as described in Section 6.8.4.

Two zones of groundwater have been identified: a shallow zone extending from the water table to a depth of about 30 feet (depth of the fill/native soil contact) and a deeper water-bearing zone. Diaphragm walls would prevent shallow groundwater from infiltrating the excavation, reducing the volume of shallow groundwater that would be discharged. Preliminary analyses from the design team indicate that pumping rates within the south area would range from 100 to 500 gallons per minute (gpm) per 600 feet of open excavation.

If H_2S is encountered, special procedures may be required, including monitoring and mechanical ventilation of excavations. For any dewatering activities that encounter H_2S dissolved in the groundwater, treatment would most likely be required before discharge.

Water that is discharged to the combined sewer may require treatment to comply with the conditions in King County's Wastewater Discharge Permit or Authorization. Water that is discharged to the ground surface would meet Washington's Water Quality Standards for Groundwater (WAC 173-200). Water from dewatering activities that is directly reinjected to mitigate potential settlement of nearby structures would not degrade groundwater quality. Under the Bored Tunnel Alternative, the project would likely be considered a large-volume discharger, because it would likely produce more than 25,000 gallons per day during the wet season (November through April). The volume for construction site dewatering would be determined once the construction methods and sequencing have been established. The discharge limits are site-specific and have not been determined at this stage of the design. If the volume of water exceeds King County's or Seattle's sewer capacity, it would be temporarily stored on site, reinfiltrated, or transported off site for disposal. Handling and disposal of water generated during dewatering is addressed in Appendix O, Surface Water Discipline Report.

Groundwater Flow

Dewatering would be required for the construction of the cut-and-cover tunnels, most of the retained cut sections, and excavations for the tunnel operations building. Dewatering would alter the groundwater flow and the distribution and concentrations of contaminants in any contaminated groundwater plumes within the zone of influence of the dewatering. Reinfiltration of groundwater to mitigate potential settlement of nearby buildings would also create a hydraulic barrier that would reduce potential changes in groundwater flow patterns due to dewatering.

Installation of temporary or permanent barriers to groundwater flow could result in crossgradient migration of contaminated groundwater, potentially contaminating areas adjacent to the constructed, less permeable zone. Permanent ground improvement extending below the water table is expected to be necessary in a block area in the south end. Diaphragm walls for the cut-and-cover tunnel and most of the retained cuts in the south area would also extend below the water table.

Ground freezing is another method of ground improvement that would provide a barrier to groundwater flow into an excavation, in much the same manner as a diaphragm wall. Typically, freeze pipes are installed to achieve blocks of frozen soil. The refrigeration coolant is circulated through the pipes. Groundwater movement and salinity can hamper the freezing efforts, requiring longer periods or reducing the temperatures necessary for achieving an adequate diameter of frozen ground and continuity between freeze pipes. A consistent line and grade must be maintained to freeze blocks of ground.

Ground freezing is a temporary measure to alter (cut off) groundwater flow and provide support for an excavation. Although technically feasible, ground freezing in the south area would not by itself satisfy the long-term structural requirements of the Bored Tunnel Alternative. Additional permanent structural support and waterproofing for the tunnel operations building and the cut-and-cover tunnel would still be necessary. Potential impacts from ground freezing would include disturbance at the ground surface due to extensive networks of circulation pipes and refrigeration equipment, as well as a potential for chemical release from a leak in the refrigeration system. In addition, frozen soil could heave and cause soil deformation around the frozen zone.

For both ground freezing and diaphragm walls, dewatering would be required to lower the groundwater table within the excavation until the permanent structure is completed.

Air Quality

Air quality could be adversely affected by contaminated soil. If surface material and near-surface soil are dry, dust could be generated during excavation and handling activities. Dust from contaminated stockpiled soil could also be released into the air. However, most of the excavated material is expected to be moist to wet, reducing the potential for dust during handling and from stockpiles. In addition, gasoline and gasoline-related VOCs such as benzene could be released.

ACM and LBP could be released during building demolition. Building surveys to identify these materials are necessary to comply with the conditions of the DPD demolition permit. As discussed in Section 6.7, Worker Safety and Public Health and Safety Concerns, demolition of structures containing ACM and LBP must protect site workers from exposure as required by WAC 296-155-17607. Mitigation measures for handling and disposing of the ACM and LBP debris are also discussed in Section 6.8.5.

6.2.2 Central Area

The bored tunnel alignment would extend from near S. Dearborn Street at the south end, generally along Alaskan Way, west of the existing Alaskan Way Viaduct. North of S. Washington Street, the tunnel would extend north until it would be located beneath First Avenue. The tunnel would continue along First Avenue until about Stewart Street, where it would trend north again until it ends near the intersection of Sixth Avenue N. and Thomas Street. The bored tunnel would be approximately 1.76 miles long and 56 feet in diameter (outside edge of the liner). At the south portal, the tunnel invert would be about 80 feet bgs. The maximum depth of the tunnel invert (about 270 feet bgs) would be located near Virginia Street. At the north portal, the tunnel invert would be about 90 feet bgs. The roadway in the bored tunnel would be a double-level configuration, with the southbound lanes on the upper level and the northbound lanes on the lower level.

The bored tunnel would be constructed using an earth pressure balance (EPB) TBM. EPB TBMs are more suitable for fine-grained clay and silt soils than other types of TBMs. The excavated material exiting through the screw conveyor of the EPB TBM would generally consist of wet, cohesive mud with a toothpaste-like consistency. This excavated material would be transported via conveyors or muck cars to the starting point of the tunnel for transfer into trucks, railcars, or barges for off-site disposal.

Ground improvement may be performed along the tunnel alignment to improve soil behavior and mitigate potential ground loss. Ground improvement along the bored tunnel is expected to consist of jet grouting or compensation grouting. It may be performed above the tunnel launching and receiving areas as well as between S. Dearborn Street and S. Jackson Street, where the recent deposits of soil consist of loose fill with localized areas containing wood debris. Compensation grouting, performed through the tunnel liner or from the ground surface, would mitigate ground loss during tunneling, or beneath structures where settlement is expected or detected during construction of the bored tunnel. With compensation grouting, grout is injected into the ground beneath the structure foundation, forming a grout bulb. Spoils are generated by the advancement of the grout hole.

Another potential ground improvement method is ground freezing. As described for groundwater flow in the south area, this method may require the installation of freeze pipes to achieve blocks of frozen soil. Ground freezing could be used to form a stiffened arch around the crown of the tunnel and would likely yield similar results as the jet grout arch. It could improve the strength and behavior of the soils in the tunnel crown with more certainty than jet grouting. An advantage of ground freezing is its ability to be implemented horizontally from an access shaft, reducing total drilled footage and the associated cost. It could also be implemented from the ground surface. Additionally, ground freezing does not result in blind spots or a reduction in the diameter of improved soil in the same manner as jet grouting. Depending on the areas and depths that are subjected to ground freezing, contaminated soil could be removed during the installation of the freeze pipes.

Contaminated Spoils

The bored tunnel would advance through native soil, except for a few hundred feet at the south end of the tunnel. Along Alaskan Way S., localized contamination of native soil may be associated with treated piles. Ground improvement techniques that access subsurface soils from the ground surface would advance through contaminated fill soils, particularly at the south end of the tunnel, south of Marion Street. The spoils from compensation grouting accomplished through the tunnel liner are unlikely to be contaminated because the grouting would occur at depths beyond which contamination would be expected. The grouting spoils would be extracted through pre-established holes in the tunnel liner.

Approximately 49,000 cy of spoils would be generated by jet grouting to strengthen the soils above the tunnel. The estimated volumes of spoils that would be removed during construction are summarized in Exhibit 6-1. Assuming an advance rate of 30 feet per day, approximately 2,200 to 4,100 cy (3,900 to 6,600 tons) of soil would be generated each day. The muck may be treated to remove solids. Due to the depth of the bored tunnel and its advancement through native soil, the percentage of contaminated spoils removed in the central area is likely to be less than that in the south and north areas. Along the waterfront, creosote-treated piles may have contaminated the native soil. Elevated concentrations of metals generally less than the MTCA Method A cleanup levels could be encountered. Isolated detections of organic contaminants are possible. An estimated 6 percent of the spoils from the bored tunnel section may contain contaminants. Other spoils may require special handling and disposal because of elevated pH, debris, or organic matter (wood waste). Glacially deposited soil may have elevated pH levels (>8.5), based on experience related to a tunnel recently advanced in east Seattle. In addition, construction additives mixed with soil may increase the pH of the spoils.

Handling and disposal of spoils from the bored tunnel section could result in significant adverse effects; however, the potential effects from spoils management would be mitigated by the development and implementation of construction management plans. Contaminated media and pollution prevention, logistical planning, and the establishment of a budget that reflects the costs of managing and disposing of contaminated media would be addressed in the plans.

Dewatering and Contaminated Groundwater

The depth to groundwater and the quality of groundwater in the southern portion of the bored tunnel section are similar to the conditions in the south area. As the elevation of the ground surface continues to increase, the depth to groundwater increases to approximately 80 feet near the north end of the tunnel section. The EPB TBM that would be used is designed to keep pressures relatively equal inside the tunnel and in the surrounding soil to reduce the potential for soil loss and sinkholes. Dewatering would not be required except in the event of a major failure of the TBM in an area of high groundwater pressure. Under these circumstances, water to be discharged to the combined sewer may require treatment to comply with the conditions of the King County's Wastewater Discharge Permit or Authorization. Significant adverse effects from dewatering are not expected, unless the TBM malfunctions.

Groundwater Flow

Localized areas of ground improvement could alter groundwater flow. Groundwater mounding along the bored tunnel north of Yesler Way is not expected. The lower aquifers that intersect the 56-foot-high tunnel horizon are widespread, interconnected, and highly pervious, allowing water to flow around the tunnel.

Air Quality

The potential is quite low for contaminated soil to adversely affect air quality during construction of the bored tunnel. The soil would be removed from the tunnel as muck. The muck would be contained, and the spoils would be stockpiled for off-site disposal. Because the material would be moist to wet, little dust from the stockpiles is expected. Soil removed during the installation of drilled shafts would also be moist to wet because these borings would extend past the water table. Gasoline and gasoline-related VOCs such as benzene have not been identified in the soil that would be removed in the central area. ACM and LBP may be present on the Alaskan Way Viaduct. Potential adverse effects on air quality from these materials are discussed in Section 6.2.1. Mitigation measures for ACM and LBP are discussed in Sections 6.7 and 6.8.5.

6.2.3 North Area

At the north portal of the tunnel, near the intersection of Sixth Avenue N. and Thomas Street, the double-level roadway would exit the tunnel and extend north into a cut-and-cover tunnel for the first 450 feet as it unbraids, and the excavation becomes shallower. At the north end of the cut-and-cover section, the northbound and southbound roadways would be side-by-side and about 35 feet and 20 feet bgs, respectively. The excavation would be about 150 feet wide. From this point northward, two separate excavations may be performed to construct the side-by-side retained cut roadways. The retained cut roadways would continue north until they reach existing grade near Broad Street, which would be filled in as part of the Bored Tunnel Alternative. At the tunnel portal near Thomas Street, the retained excavation would be about 70 feet wide and 90 feet deep to receive the TBM at the completion of tunnel boring. Along the cut-and-cover section in the north area, the retained excavation would be filled in after the roadway structure is constructed. The surface streets above the SR 99 roadway area would then be connected at John, Thomas, and Harrison Streets.

A connection from Mercer Street to the surface street grid would be built along Sixth Avenue N. Sixth Avenue N. would be constructed in a curved formation between Harrison and Mercer Streets. There would be a signalized intersection at the midpoint between Mercer and Harrison Streets for the on-ramp connecting to southbound SR 99.

The existing retained cut along Mercer Street would be widened from four to six lanes to accommodate two additional lanes of traffic. Construction of this connection and the roadway widening would require demolishing portions of the existing retaining walls at Mercer and Broad Streets. New retaining walls would not be required along the south side of Mercer Street from about Fifth Avenue N. to SR 99 and along the west side of Sixth Avenue N. between Mercer Street and Harrison Street because of a future planned development by the Gates Foundation that would lower the grade south of Mercer Street. The north area would also include a tunnel operations building.

Contaminated Spoils

Contaminated spoils would likely be encountered in the north area. Five categories of soil would likely be excavated in this area, including the four categories described for the south area:

- Clean soil
- Class II impacted soil
- Problem waste
- Dangerous waste: characteristic dangerous waste based on a leaching test

Dangerous waste that would be encountered in the north area would likely be contaminated with solvents from dry-cleaning operations, which are regulated under the dangerous waste regulations and include the following:

- F-listed waste (on EPA's list of hazardous wastes) associated with a dry-cleaning operation. This waste may also require testing for its characteristic properties; solvent must leach from soil at less than its respective TCLP criterion, which for tetrachloroethylene is 0.7 mg/L.
- Contained-out waste from a dry-cleaning operation with a solvent concentration less than the MTCA Method B cleanup level for the respective solvent. This site-specific designation would be provided by Ecology.

Depending on the level and type of contamination (clean, low, or greater than the MTCA Method A cleanup levels), the spoils may be transported to a land reclamation facility or a RCRA Subtitle D landfill.

Dangerous waste must be disposed of at a RCRA Subtitle C landfill. Soil contaminated with dry-cleaning solvents requires special handling and disposal. Soil disposal options are discussed in Section 6.8.5.

Characteristic dangerous waste could be present. These soils would have concentrations of metals greater than the characteristic dangerous waste criteria (TCLP criteria). To date, elevated concentrations of metals have not been encountered during explorations in the north area.

Solvent-contaminated soil from a dry-cleaning operation has been detected at the Vagabond Inn site (Site 60.3-1, currently the Seattle Pacific Hotel), the parcel adjacent to the proposed location of the tunnel operations building. A laundry that may have had dry-cleaning operations (currently a City of Seattle maintenance yard) was located in the proposed retained cut section of the alignment, one block north of the

Vagabond Inn site. Gas stations and auto repair shops operated adjacent to the proposed alignment, and these operations may have released petroleum products.

The estimated volume of material to be excavated in the north area is 233,000 cy, as indicated in Exhibit 6-1. Approximately 160,500 cy of the spoils would require special handling because of contamination. Site excavation would result in 145,000 cy of spoils, and clearing existing pavement and structures would result in approximately 88,000 cy of debris.

The estimated quantities of the expected soil categories are indicated in Exhibit 6-2. For this evaluation, soils in the Class II and problem waste categories are grouped together as contaminated soil. The evaluation also assumes that the excavated soil is assigned to the most restrictive category (with no overlap). The quantities of dangerous waste and contained-out waste are based on limited available data. WSDOT conducted a site investigation to evaluate soil near the north tunnel operations building for a contained-out designation. Ecology must issue a contained-out designation for qualifying soils. The estimated volumes of soil that would be removed during construction and the assumptions used for the estimates are summarized in Exhibits 6-1. Similar to the south area, handling and disposal of spoils from the north portal area would result in a significant adverse effect. A maximum of 2,800 cy (approximately 5,000 tons) of soil per day could be excavated in the north area. A waste disposal company operating in the area has estimated that it can accept 2,200 to 2,700 cy of material per day, assuming two shifts of work.

Exhibit 6-2. Estimated Excavation Quantities That Would Likely Require Special Handling and Disposal in North Area for Bored Tunnel Alternative

	At-Grade (cy)	Excavated (cy)
Total excavated soil volume (see Exhibit 6-1)	88,000	145,000
Contaminated or special handling required	88,000	72,500
Detailed Estimate		
Dangerous waste from dry cleaning	–	1,600
Contained-out waste	4,400	34,650
Contaminated soil and demolition debris [1]	83,600	36,250
Total demolition and excavation in north area	88,000	72,500

Notes:
cy = cubic yards
[1] Contaminated soil includes the soil categories Class II impacted soil and problem waste.

The estimated quantities of soil for the Bored Tunnel Alternative are based on the following information:

- **Bored tunnel.** Contaminated fill and properties on which dry cleaners operated located in the immediate vicinity of the north end of the bored tunnel (100 feet of the tunnel or about 1 percent is assumed to be contaminated).

- **Contained-out waste.** Based on available data, historical site uses (Vagabond Inn [Site 60.3-1] and the City of Seattle maintenance yard [Site 50.1-1]), and the percentage of soil contaminated with solvents.
- **Contaminated waste.** Remaining quantity, after subtracting the dangerous/F-listed waste and contained-out waste from the total volume of contaminated soil.
- **Dangerous waste.** Dangerous waste is known at the Vagabond Inn (Site 60.3-1). A portion (25 percent) of the secant pile wall adjacent to the property is assumed to be contaminated. No dangerous waste has been identified for the City of Seattle maintenance yard (Site 50.1-1).
- **North portal.** Between Stations 300+00 and 304+40, half of the estimated total quantities are assumed to be contaminated (northbound roadway, closest to the Vagabond Inn [Site 60.3-1]). Between Stations 304+40 and 310+50, half of the secant wall is assumed to be contaminated (closer to the former laundry that had dry-cleaning operations at the current City of Seattle maintenance yard [Site 50.1-1]), and half of the total structure excavation is contaminated.

Spoils Disposal

If necessary, two or more waste handlers could be used for spoils disposal. Excavated soil would be hauled by truck to staging areas identified in the south area or directly to the spoils loading area. Spoils could be routed to multiple facilities or stockpiled until the facility's operations could accommodate them. The material would then be transported by rail or barge to a facility that is permitted to accept the material. If contaminant concentrations exceed the dangerous waste criteria, the material would require disposal at a RCRA Subtitle C landfill. Handling, storage, and transport measures would need to comply with RCRA. Contained-out designated soil can be taken to a Subtitle D landfill. Requirements for a contained-out designation are discussed in Section 6.8.5.

Additional characterization sampling would be needed if unknown contamination is encountered during ground-disturbing activities. Schedule delays would occur and costs would increase if additional testing is required. With expedited analysis of the soil, the project could be delayed from a few days to a few weeks, depending on the volume of soil, the number of samples, and the review and acceptance of the analytical data by the disposal company. Costs for analytical testing are provided in Section 6.9.1. Costs associated with stockpiling soil could range from $3.00 to $5.00/cy and would depend on the distance they would need to be transported and the logistics of the stockpile site. If no predesignation can be accomplished and all the soil has to be stockpiled, the project could incur significant delays and costs associated with the additional handling and testing. Unit costs for disposal of the various categories of waste are provided in Section 6.9.3. Handling and disposal options are indicated in the *Draft Spoil Handling and Disposal Planning Report* (PB 2009b).

Dewatering and Contaminated Groundwater

Multiple perched aquifers are present in the north area. The regional groundwater table is approximately 70 to 80 feet bgs. Dewatering pumping rates for perched aquifers are estimated at 5 to 100 gpm. A more permeable intermediate perched aquifer could require pumping rates of 100 to 600 gpm. Depressurizing the deep aquifer could require pumping rates of 50 to 200 gpm.

Localized areas of contamination have been identified within the perched groundwater. Tetrachloroethylene has been detected in perched groundwater in the vicinity of Aurora Avenue N. and Republican Street, where the ramps are approximately 5 to 10 feet bgs. Groundwater in this monitoring well (AB-4) is approximately 6 feet bgs. It is perched on silty to clay fill with scattered layers of sand. Depth to water in a well at Harrison Street and the west side of SR 99, near the Vagabond Inn site (Site 60.3-1, currently the Seattle Pacific Hotel) has been measured at 15 feet bgs; it is perched on peat and underlain by clay to 33 feet bgs. In the north area, the lenses of water-bearing sand are not laterally continuous and are underlain by fine-grained soil, including clay and peat. Monitoring wells are slow to recover. Dewatering in these circumstances would likely be accomplished with the use of a sump pump in the excavation.

The results of recent explorations (2010) confirm that groundwater perched at a depth of approximately 60 feet bgs and shallower in the vicinity of the Vagabond Inn site is contaminated with dry-cleaning solvents, including tetrachloroethylene and its breakdown products. The north tunnel operations building would be constructed adjacent to this site. The excavation for the tunnel operations building would range from about 50 feet bgs at the north end of the block to 80 feet bgs midblock and south. Dewatering of the perched water would likely be necessary adjacent to the Vagabond Inn site, and the water is expected to be contaminated with tetrachloroethylene. The regional aquifer may be dewatered for the construction of south part of the tunnel operations building and the north portal of the bored tunnel.

Groundwater extracted during dewatering that is contaminated with spent dry-cleaning solvents, as the groundwater at the Vagabond Inn site, is an F002[2] listed

[2] F002 is a category of halogenated solvents designated as hazardous waste by the EPA, as defined in Code of Federal Regulations, Title 40, Section 261.31.

dangerous waste regardless of the concentrations of the solvents. The water could be treated on site or at a TSD facility by passing it through a granular activated carbon (GAC) filter. The water could be discharged to a publicly owned treatment works (POTW) that permits the discharge, or it could be transported to a TSD facility for disposal through the facility's permitted process. Groundwater designated as F002 dangerous waste is prohibited from being discharged to the ground or to surface water. The waste handling requirements described above also extend to solvent-contaminated spoils from adjacent properties that are believed to be adversely affected by the dry-cleaning operation. These waste designations do not apply to these solvents if they were used for other applications and operations, such as a degreasing agent at an auto repair operation.

Petroleum contamination is also likely at the north portal. Gas stations and auto repair business were formerly located along Aurora Avenue N. Depending on the concentrations of petroleum and petroleum-related VOCs in the groundwater, the water may require treatment before discharge.

Water that is to be discharged to the sewer system may require treatment before discharge, in accordance with the conditions of the King County Wastewater Discharge Permit or Authorization. Water with contaminant concentrations exceeding the water quality criteria would be treated on site before it is discharged, or it would be transported off site for treatment and disposal. Discharge rates and volumes are project specific and are established once the construction methods and sequencing have been determined. If the volume of water exceeds King County's or SPU's combined sewer capacity, it would be temporarily stored on site or transported off site for disposal. On-site storage of large volumes of water would present a problem because few of the staging areas are located in the north area. Water contaminated with solvents from dry-cleaning operations could require treatment before off-site disposal. Water would be managed and disposed of in accordance with federal, state, and local regulations.

Groundwater Flow

Substantial dewatering is not expected to be necessary for most of the proposed excavations in the north area because the regional water table is located more than about 70 feet bgs. Dewatering of the regional groundwater could be necessary at the north portal and in a portion of the excavation for the north tunnel operations building. This would alter the groundwater flow and the distribution and concentrations of contaminants in any contaminated groundwater plumes within the dewatering zone of influence.

Perched groundwater occurs in sand lenses underlain by silty to clay fill and/or peat and fine-grained fill. Perched seepage zones may exist above the regional water table; however, sumps and pumps in the excavations can typically control this seepage. The regional groundwater gradient is relatively flat, and may be toward the south in the areas that would be dewatered. Depending on the location of the dewatering well(s) and the pumping rate, the cone of depression could extend to the adjacent property. Contaminated groundwater could be encountered and drawn into areas that were previously uncontaminated, and discharge from dewatering operations could contain hazardous materials.

Significant adverse effects associated with dewatering efforts in the north area are not expected. The contractor would prepare a plan that describes the dewatering approach, including water treatment and discharge. This plan would address petroleum-contaminated water and standard treatments for removing solvents. Because of a stepped foundation, only a portion of the tunnel operations building would extend 10 to 20 feet into the regional aquifer. Construction techniques that limit dewatering could be implemented in this area.

Air Quality

Air quality in the north area could be affected by dust from contaminated stockpiled soil. During of the excavation for the north tunnel operations building, dry-cleaning solvents in soils could volatilize and affect the environment, workers, and the public. To minimize potential exposure, Ecology does not permit the stockpiling of contained-out soil at a site unless it is conducted in accordance with the dangerous waste rules (WAC 173-303-200). Gasoline-contaminated soil may also be encountered during the removal of soils from former gas station sites.

ACM and LBP are likely present in the north area. A building constructed in 1957 would be demolished as part of the Bored Tunnel Alternative. A survey to determine the presence and distribution of ACM and LBP would be necessary to comply with the conditions of the DPD permit for demolition. Adverse effects on the air quality attributed to buildings with ACM and LBP are discussed in Section 6.2.1.

6.2.4 Viaduct Removal

Demolition of the existing Alaskan Way Viaduct would likely be performed using hoe-rams and other vibratory equipment. The viaduct bents would be removed to approximately 5 feet bgs and, in some locations, deeper to accommodate future underground utilities. Utilities currently attached or suspended on the viaduct structure would need to be relocated, which would require some excavation. The location or depth of the excavations has not yet been determined, but the utilities would be located adjacent to the existing structure and could be buried to depths of 4 to 6 feet, and possibly more in a few cases, depending on the utility type.

ACM and LBP may be present on the viaduct. Potential adverse effects on air quality attributable ACM and LBP are discussed in Section 6.2.1. Contaminated soils and groundwater have been documented near the viaduct. WSDOT is the lead agency responsible for the management of contaminated soils and groundwater for the viaduct removal.

6.2.5 Battery Street Tunnel Decommissioning

The Battery Street Tunnel would be decommissioned as part of the Bored Tunnel Alternative. As part of the decommissioning process, proper management and disposal of ACM and LBP debris would be required. In samples of soot collected from the tunnel lining, concentrations of cadmium, lead, cPAHs, and oil-range hydrocarbons exceeded the MTCA Method A cleanup levels for unrestricted land use. Arsenic also exceeded the MTCA Method A cleanup level in a few of the samples. Testing by TCLP indicated that lead concentrations exceeded the dangerous waste threshold in five of the six samples, and cadmium exceeded the threshold in one sample (Taylor 2007). These materials could become airborne. Any hazardous materials present in the tunnel would need to be removed before decommissioning. An estimated 107,000 cy of debris is expected to be generated during the demolition of the Alaskan Way Viaduct.

One possible decommissioning option includes partially filling the tunnel with the concrete debris recycled from the viaduct demolition. The remainder of the empty space in the tunnel would then be filled with CDF to provide a continuous backfill. The demolition debris would be appropriately managed and handled to address the specific environmental hazards associated with concrete rubble, including an elevated pH. In addition, necessary regulatory permits and approvals would be procured if they are determined to be necessary to perform this type of construction activity.

6.3 Construction Effects of Cut-and-Cover Tunnel Alternative

The Cut-and-Cover Tunnel Alternative would include a combination of cut-and-cover tunnel sections, retained cut sections, and elevated structures to replace the existing Alaskan Way Viaduct from south of S. Royal Brougham Way to Aloha Street, north of the Battery Street Tunnel. The proposed alignment generally follows the existing SR 99 alignment and is located between the Elliott Bay Seawall and the existing viaduct in the central area. This alternative also includes improving the Battery Street Tunnel and the seawall. Other features included in the Cut-and-Cover Tunnel Alternative are improvements to the area north of the Battery Street Tunnel, relocation of utilities, construction of temporary ferry access and holding facilities, and the temporary relocation of the Washington Street Boat Landing. Detailed descriptions of the proposed roadway alignment and features are provided in Appendix B, Alternatives Description and Construction Methods Discipline Report.

Construction effects for the Cut-and-Cover Tunnel Alternative are discussed below for each area of the alignment. For the discussion of the Cut-and-Cover Tunnel

Alternative, the Battery Street Tunnel and the north waterfront, north of Pike Street to Broad Street, have been identified as distinct areas. The north waterfront area encompasses the seawall where it deviates from the SR 99 alignment. The estimated volume of material that would be excavated or generated as spoils is 2,007,000 cy (Exhibit 6-3). About 70 percent of the material (1,437,000 cy) would be considered potentially contaminated or require special handling.

Air quality could be adversely affected by contaminated soil, which is present along the entire alignment. As discussed in Section 6.2.1, dust could be generated during excavation and handling activities. However, most of the excavated material is expected to be moist to wet, reducing the potential for dust during handling and from stockpiles.

ACM and LBP would likely be encountered in all areas of the project construction. Potential adverse effects on air quality associated with ACM and LBP are discussed in Section 6.2.1. Mitigation measures are discussed in Section 6.7, Worker Safety and Public Health and Safety Concerns, and Section 6.8.5, Contaminated Media Handling and Disposal Options.

6.3.1 South Area

In the south area, the roadway for the Cut-and-Cover Tunnel Alternative would begin as an elevated structure south of S. Royal Brougham Way. North of S. Royal Brougham Way, the roadway would transition from at-grade into a retained cut along a length of about 1,200 feet. The roadway would then transition into the entrance of the cut-and-cover tunnel near S. Dearborn Street.

The elevated structures and ramps would be supported on cast-in-place concrete piles and/or drilled shafts. The retained cut sections would be supported by secant pile or slurry walls. Effects from these construction methods are discussed in Section 6.2.1.

Ground improvement would be performed around existing and proposed foundations and west of the roadway alignment. Potential ground improvement methods and their effects are discussed in Section 6.1.

Similar to the Bored Tunnel Alternative, construction of the retained cut, cut-and-cover tunnel, diaphragm walls, and at-grade structures would result in approximately 197,000 cy of spoils, of which approximately 75 percent (151,000 cy) would require special handling. Potential adverse effects from this volume of spoils are described in the discussion of the Bored Tunnel Alternative (Section 6.2).

As part of the temporary realignment of the Alaskan Way Viaduct, railroad tail tracks would be relocated during construction to avoid interruption of BNSF Railway operations. The shallow soil consists of fill from an unknown source. Because the area is an active and long-standing railyard, it is likely that petroleum-contaminated soil and ballast would be encountered.

Exhibit 6-3. Estimated Excavation Quantities for Cut-and-Cover Tunnel Alternative

Area	Clear Existing Rail, Ballast, Ties, Obstructions (Demolition) [1] (cy)	Clear Existing Pavement, Structures, Obstructions [2] (cy)	Retained Cut (cy)	Cut-and-Cover Tunnel (cy)	Diaphragm Walls Excavation (cy)	Drilled Shafts (cy)	Deep Soil Mixing [3] (cy)	Jet Grouting [4] (cy)	Stone Columns (cy)	Site Excavation [5] (cy)	Structural Excavation [6] (cy)	Soil Boring for Tunnel (cy)	Total Excavation (cy)
Total Excavation Quantities													
South		46,000	56,000	73,000	14,000		8,000						**197,000**
Central	5,000	55,000	139,000	934,000	76,000	4,000				19,000	3,000		**1,235,000**
Battery Street Tunnel		15,000	8,000	51,000							6,000		**80,000**
North of Battery Street Tunnel		67,000	161,000		34,000						10,000		**272,000**
North waterfront	9,000	38,000						97,000		79,000			**223,000**
Totals:	**14,000**	**221,000**	**364,000**	**1,058,000**	**124,000**	**4,000**	**8,000**	**97,000**		**98,000**	**19,000**		**2,007,000**
Excavation Quantities - Potentially Contaminated or Requiring Special Handling and Disposal													
South		46,000	56,000	36,000	5,000		8,000						**151,000**
Central	5,000	55,000	136,000	606,000	46,000	2,000				11,000	2,000		**863,000**
Battery Street Tunnel		15,000	8,000	7,000							3,000		**33,000**
North of Battery Street Tunnel		67,000	81,000		17,000						5,000		**170,000**
North Waterfront	9,000	38,000						97,000		76,000			**220,000**
Totals:	**14,000**	**221,000**	**281,000**	**649,000**	**68,000**	**2,000**	**8,000**	**97,000**		**87,000**	**10,000**		**1,437,000**

Notes:

The indicated quantities are for the alternative shown in the conceptual drawings dated August 2010.

For the purposes of these estimates, quantities have been calculated for the cut and fill items noted. Actual import and export quantities may be less than those indicated as portions of these materials may be stored on site and reused.

For this alternative, the Battery Street Tunnel and the north waterfront, north of Pike Street to Broad Street, have been identified as distinct areas. The north waterfront area encompasses the seawall where it deviates from the SR 99 alignment.

An underlined value indicates that a portion of the excavation quantity does not require special handling and disposal (the volume is less than the total quantity volume).

cy = cubic yards

[1] Estimated quantity to clear existing waterfront trolley ballast and ties. Assumed depth is 2 feet, 6 inches.

[2] Estimated quantity to clear existing roadway pavement and miscellaneous structures. Assumed depth is 2 feet.

[3] Volume assumes ground improvement is equal to 35 percent of the total improved soil mass, and 30 percent of this volume is returned to the surface as soil-cement spoils.

[4] Estimated spoils (49,000 cy) from jet grouting operations that overlap the Elliott Bay Seawall Project in the south. Spoil volume was calculated assuming 100 percent of the improved soil mass is covered, and 25 percent of this volume is returned to the surface as soil-cement spoils.

[5] Estimated quantity of general site excavation, not otherwise classified.

[6] Estimated quantity of excavation for structures, abutments, large utility vaults, etc.

6.3.2 Central Area

The Cut-and-Cover Tunnel Alternative in the central area would consist primarily of a stacked, six-lane tunnel (three lanes in each direction). The west side of the tunnel in most areas would replace the existing seawall. At the south end of the tunnel, the northbound portal would be located just south of S. Dearborn Street, and the southbound portal would be located about 450 feet to the north. The tunnel would be a maximum of about 90 feet wide, and at its maximum depth, it would be about 86 feet deep (between S. Main Street and S. Washington Street). Diaphragm walls would support the sides of the tunnel. A diaphragm wall would be constructed using drilled shafts (secant or tangent) and/or slurry wall techniques to form a continuous reinforced-concrete wall that provides lateral support and serves as an impermeable barrier. Ventilation structures and emergency egresses would be constructed at various locations along the tunnel.

Between Pine Street and the Battery Street Tunnel, the cut-and-cover tunnel would transition to a retained cut section, then to a fill embankment supported by a mechanically stabilized earth wall, and finally to an elevated structure. Near Lenora Street, the elevated structure would transition into a retained cut, which would connect to the lowered roadway of the Battery Street Tunnel. The transition through the south retained cut section would require a vertical cut into the existing hillside below the viaduct. This cut would be supported by a retaining wall with tiebacks extending under the existing viaduct. Large-diameter drilled shafts would support the elevated structure south of the Battery Street Tunnel.

Two tunnel maintenance buildings would be constructed for the Cut-and-Cover Tunnel Alternative. The south maintenance building would be on top of the tunnel structure, and the north maintenance building would be constructed adjacent to the west side of the north portal of the tunnel.

Ground improvement in the central area may be performed beneath the proposed support facility (near Railroad Way S.) and the north portal maintenance building. Another location of ground improvement would be below the tunnel base slab south of Railroad Way S. as the tunnel rises toward the ground surface at the south portal. The impacts of ground improvement at these locations would be similar to those discussed in the south area for the Bored Tunnel Alternative (see Section 6.2.1).

In contrast to the bored tunnel, the entire construction of the cut-and-cover tunnel and seawall through downtown Seattle would occur in an area that has already been filled. The fill along the waterfront is up to 50 feet thick and is from unknown sources. An elevated railroad trestle and/or elevated wood-plank road were constructed along the former waterfront; consequently, the former ground surface may have been contaminated with low concentrations of petroleum due to small releases from the railcars and/or vehicles. In addition, creosote-treated timbers may have been used to support the former trestles and piers; contamination from these timbers likely leached into the adjacent soil. Native soil from the fill contact to the tunnel floor slab (maximum of 86 bgs) could be contaminated locally.

Fill soil would be removed from drilled shafts for the seawall, elevated structures, and pile caps adjacent to Alaskan Way to relocate utilities and vaults. The excavated fill soil would likely contain localized petroleum and creosote contamination, as well as creosote-treated timbers. Elevated concentrations of metals have also been identified sporadically in fill along the waterfront.

An estimated 1,235,000 cy of spoils would be removed in the central area, including the spoils from construction of the cut-and-cover tunnel, retained cut, diaphragm wall, and drilled shafts. Spoils from the demolition of the existing viaduct and the at-grade demolition along Alaskan Way are also included in this estimate. About 70 percent of the spoils (863,000 cy) would require special handling. Another 80,000 cy of spoils would be generated during the construction of improvements to the Battery Street Tunnel. These spoils would result from excavation to increase the vertical clearance inside the tunnel. About 41 percent of these spoils (33,000 cy) would require special handling. Potential adverse effects from this volume of spoils are described in the discussion of the Bored Tunnel Alternative (Section 6.2).

During the installation of drilled shafts and/or cast-in-place piles, shallow groundwater and/or water used to stabilize the hole may have a pH greater than 10 because of its contact with the grout.

With the Cut-and-Cover Tunnel Alternative, storm sewer outfalls for Washington, Madison, University, and Vine Streets would be rebuilt for the Cut-and-Cover Tunnel Alternative. The pipe would be constructed above the relieving platform for University and Vine Streets. If contaminants are present upgradient of these outfalls, the reconstructed outfalls could create preferential pathways for contaminant migration. The backfill material along the entire downgradient portion of the utility corridor could become contaminated. Similarly, backfill that would be excavated from around the existing outfalls could be contaminated. Sediment near the outfalls would be disturbed during reconstruction. The sediments, particularly shallow sediments, may be contaminated with PAHs and heavy metals. Impacts from sediment that could be resuspended are discussed in Appendix O, Surface Water Discipline Report.

Pumping tests conducted for the project indicate that prolonged construction dewatering associated with cut-and-cover tunnels along the waterfront could result in a large area of drawdown if not mitigated. This could potentially mobilize groundwater contaminants toward the alignment from large distances. Additionally, downward vertical gradients developed from drawdown could increase vertical migration of contaminants from the shallow soils. Such contaminant mobilization could affect the treatment of groundwater from dewatering activities.

Dewatering along the cut-and-cover tunnel would be accomplished using a series of dewatering wells installed both within the area to be excavated and below the bottom elevation of the excavation. Three zones of dewatering have been identified, based on potential pumping rates and water-table drawdown. Near S. Jackson Street, the pumping rate is estimated to be about 115 gpm along a 600-foot-long excavation. Near Spring Street, the pumping rate would be similar, 100 gpm along a 600-foot-long excavation, but potential drawdown could be about 15 feet bgs 50 feet east of the tunnel. The highest pumping rate would be near Union and Pike Streets, with a pumping rate of 500 gpm along a 400-foot-long excavation. Drawdown could be about 45 feet bgs. The potential effects of and mitigation for dewatering are discussed in Section 6.2.

H_2S may be encountered in excavations along the waterfront. Its presence is documented at the intersection of University Street and Alaskan Way. The presence of H_2S as a gas may require special procedures to protect workers in the area. Groundwater removed from the area may also contain high concentrations of H_2S that would necessitate groundwater treatment before discharge.

Sediment would most likely be disturbed during the installation of the diaphragm wall and could become resuspended, adversely affecting surface water quality. Sediment excavation is not expected; however, if sediment is removed, its disposal would need to comply with applicable regulations. Rigorous testing in accordance with the Puget Sound Dredged Disposal Analysis (PSDDA 2011) and agency review would be required before any open water disposal could be approved. Between Piers 54 and 57, the contaminant concentrations are higher and extend to greater depths (EPA 1988). For additional information, please refer to Appendix O, Surface Water Discipline Report.

6.3.3 North Area

The Cut-and-Cover Tunnel Alternative includes lowering SR 99 north of the Battery Street Tunnel into a side-by-side retained cut between the north portal and about Mercer Street. Modifications to the existing portal walls and new retaining walls would be required.

Upgrades to the existing on- and off-ramps would also be constructed at Denny Way and Roy Street. Broad Street would be filled between Fifth and Ninth Avenues N. to reconnect the local street grid. New overpass structures would be constructed at Thomas and Harrison Streets. Mercer Street would be widened, and the existing underpass would be reconfigured.

To widen SR 99 and Mercer Street, the existing retaining walls would be removed, and soil would be excavated as part of a retained-cut, followed by construction of new retaining walls. Tiebacks would be installed for the retaining walls. Shallow excavations would be necessary to construct footings for the overpass structures.

Approximately 272,000 cy of spoils would be generated from construction in the north area, of which about 63 percent (170,000 cy) would require special handling. Contaminated spoils would result from excavation on a property where a dry-cleaner operated. The site has documented contamination. Contamination could also be associated with other properties that had dry-cleaning operations and any of the numerous gas stations adjacent to the alignment. Potential effects from spoils handling and disposal are discussed Section 6.2. The estimated quantities of the expected soil categories are indicated in Exhibit 6-4. For this evaluation, soils in the Class II and problem waste categories are grouped together as contaminated soil. The evaluation also assumes that the excavated soil is assigned to the most restrictive category (with no overlap).

Exhibit 6-4. Estimated Excavation Quantities That Would Likely Require Special Handling and Disposal in North of Battery Street Tunnel Area for Cut-and-Cover Tunnel Alternative and Elevated Structure Alternative

	At-Grade (cy)	Excavated (cy)
Total excavated soil volume (see Exhibits 6-3 and 6-5)	67,000	205,000
Contaminated or special handling required[1]	67,000	103,000
Detailed Estimate		
Dangerous waste from dry cleaning	–	1,900
Contained-out waste	13,400	17,700
Contaminated soil and demolition debris[1]	53,600	83,400
Total demolition and excavation	67,000	103,000

Notes:
cy = cubic yards
[1] Contaminated soil includes the soil categories Class II impacted soil and problem waste.

The estimated quantities of soil for the Elevated Structure and Cut-and-Cover Tunnel Alternatives are based on the following information:

- One-fifth of the total volume of contained-out waste at-grade is assumed to be contaminated with dry-cleaning solvents (3 out of 10 blocks are known to have had dry-cleaning operations; the Vagabond Inn site (Site 60.3-1) has documented contamination).

- Contained-out waste is based on the volume from the retained cut and diaphragm wall; excavation for the structure would be close to Denny Way, in an area of former and existing gas stations. The assumption is that 20 percent of the volume would be contained-out waste. This volume is based on available data, the historical site uses (Vagabond Inn [Site 60.3-1] and City of Seattle maintenance yard [Site 50.1-1]), and the percentage of soil contaminated with solvents.
- Contaminated waste volume was estimated by subtracting dangerous/F-listed and contained-out waste from the total volume of contaminated soil.
- Dangerous waste has been documented at the Vagabond Inn (Site 60.3-1). A portion (20 percent) of retained cut soil adjacent to the property is assumed to be contaminated. No dangerous waste has been identified for the City of Seattle maintenance yard (Site 50.1-1).

6.3.4 Battery Street Tunnel Improvements

The Battery Street Tunnel roadway would be lowered to maintain a 16.5-foot clearance and to match the new roadway grades at the north and south portals. The Cut-and-Cover Tunnel Alternative also includes a partial realignment/widening at the south portal. The tunnel foundation would be strengthened using such elements as micropiles. New emergency egress facilities, additional ventilation structures, and other improvements would also be constructed.

The existing construction materials would be removed and disposed of off site. As described for the Bored Tunnel Alternative, hazardous materials are present in the existing tunnel. Another 80,000 cy of spoils would be generated during the construction of the Battery Street Tunnel improvements. About 41 percent of this volume (33,000 cy) would require special handling. Potential adverse effects from this volume of spoils are described in the discussion of the Bored Tunnel Alternative (Section 6.2).

The lowering of the tunnel walls would require construction of new retaining walls. Within the tunnel, the existing tunnel walls would be extended below their current base. Temporary tieback installations associated with the retaining walls would be necessary along most of the Battery Street Tunnel. Emergency egress facilities would also require retaining walls along their perimeter. The effects related to retaining walls would be similar to those discussed in the previous sections.

Soil excavated during construction of the north portal could be contaminated because numerous gas stations were formerly located at the intersection of Denny Way and SR 99.

6.3.5 Viaduct Removal

Under all of the build alternatives, the Alaskan Way Viaduct would be demolished (see Section 6.2.4 for a description of the viaduct removal for the Bored Tunnel Alternative). Utilities currently attached to the viaduct would be relocated. Shallow excavation up to 5 feet bgs may be necessary to remove the bents and to relocate utilities. Contaminated soils have been identified in fill soil near the viaduct. Localized groundwater contamination has also been encountered. WSDOT is the lead agency responsible for management of contaminated soils and groundwater for the viaduct removal.

6.4 Construction Effects of Elevated Structure Alternative

The Elevated Structure Alternative includes replacement of the existing Alaskan Way Viaduct with a new elevated structure approximately along its current alignment, with ramps at Columbia and Seneca Streets. This alternative includes modifications similar to those for the Cut-and-Cover Tunnel Alternative in the south, Battery Street Tunnel, north of the Battery Street Tunnel, and waterfront sections. This alternative also includes replacing the Elliott Bay Seawall from S. Jackson Street to Broad Street (waterfront area). Detailed descriptions of the proposed roadway alignment and features are provided in Appendix B, Alternatives Description and Construction Methods Discipline Report.

Construction effects that could result if contaminated soil and/or groundwater are encountered during construction activities are discussed in Section 6.1. For the Elevated Structure Alternative, the estimated volume of material that would be excavated or generated as spoils is 806,000 cy (Exhibit 6-5). More than 75 percent of the material (660,000 cy) could be considered potentially contaminated or require special handling.

Air quality could be adversely affected by contaminated soil, which is present along the entire alignment. As discussed in Section 6.2.1, dust could be generated during excavation and handling activities. However, most of the excavated material is expected to be moist to wet, reducing the potential for dust during handling and from stockpiles.

ACM and LBP would likely be encountered in all areas of the project construction. Potential adverse effects on air quality attributed to structures with ACM and LBP are discussed in Section 6.2.1. Mitigation measures are discussed in Section 6.7, Worker Safety and Public Health and Safety Concerns, and Section 6.8.5, Contaminated Media Handling and Disposal Options.

Exhibit 6-5. Estimated Excavation Quantities for Elevated Structure Alternative

Area	Clear Existing Rail, Ballast, Ties, Obstructions (Demolition) [1] (cy)	Clear Existing Pavement, Structures, Obstructions [2] (cy)	Retained Cut (cy)	Cut-and-Cover Tunnel (cy)	Diaphragm Walls Excavation (cy)	Drilled Shafts (cy)	Deep Soil Mixing [3] (cy)	Jet Grouting [4] (cy)	Stone Columns (cy)	Site Excavation [5] (cy)	Structural Excavation [6] (cy)	Soil Boring for Tunnel (cy)	Total Excavation (cy)
Total Excavation Quantities													
South		39,000				22,000	23,000						**84,000**
Central		60,000				33,000				2,000			**95,000**
Battery Street Tunnel		13,000	1,000	14,000							6,000		**34,000**
North of Battery Street Tunnel		67,000	161,000		34,000						10,000		**272,000**
Waterfront	9,000	38,000						147,000		127,000			**321,000**
Totals:	**9,000**	**217,000**	**162,000**	**14,000**	**34,000**	**55,000**	**23,000**	**147,000**		**129,000**	**16,000**		**806,000**
Excavation Quantities - Potentially Contaminated or Requiring Special Handling and Disposal													
South		39,000				<u>4,000</u>	23,000						**66,000**
Central		60,000				<u>15,000</u>				2,000			**77,000**
Battery Street Tunnel		13,000	1,000	<u>7,000</u>							6,000		**27,000**
North of Battery Street Tunnel		67,000	<u>81,000</u>		<u>17,000</u>						<u>5,000</u>		**170,000**
Waterfront	9,000	38,000						147,000		<u>126,000</u>			**320,000**
Totals:	**9,000**	**217,000**	**82,000**	**7,000**	**17,000**	**19,000**	**23,000**	**147,000**		**128,000**	**11,000**		**660,000**

Notes:

The indicated quantities are for the alternatives shown in the conceptual drawings dated August 2010.

For the purposes of these estimates, quantities have been calculated for the cut and fill items noted. Actual import and export quantities may be less than those indicated as portions of these materials may be stored on site and reused.

Waterfront area includes the seawall improvements; central area includes the construction of the elevated structure.

An <u>underlined</u> value indicates that a portion of the excavation quantity does not require special handling and disposal (the volume is less than the total quantity volume).

cy = cubic yards

[1] Estimated quantity to clear existing waterfront trolley ballast and ties. Assumed depth is 2 feet, 6 inches.

[2] Estimated quantity to clear existing roadway pavement and miscellaneous structures. Assumed depth is 2 feet.

[3] Volume assumes ground improvement is equal to 35 percent of the total improved soil mass, and 30 percent of this volume is returned to the surface as soil-cement spoils.

[4] Estimated spoils (49,000 cy) from jet grouting operations that overlap the Elliott Bay Seawall Project in the south. Spoil volume was calculated assuming 100 percent of the improved soil mass is covered, and 25 percent of this volume is returned to the surface as soil-cement spoils.

[5] Estimated quantity of general site excavation, not otherwise classified.

[6] Estimated quantity of excavation for structures, abutments, large utility vaults, etc.

6.4.1 South Area

Under the Elevated Structure Alternative, the roadway configuration for the south section is similar to that described for the Cut-and-Cover Tunnel Alternative (see Section 6.3.1). The primary difference is that the north end of the elevated SR 99 roadway would extend to an at-grade section at S. Royal Brougham Way. This section would be about 800 feet long and would connect to the south end of the central section of the elevated structure south of Railroad Way S. Large-diameter drilled shafts would support the elevated structure.

Impacts from the at-grade roadway are described in the discussion of the Cut-and-Cover Tunnel Alternative (Section 6.3.1). The impacts due to retained cuts described for the Cut-and-Cover Tunnel Alternative would be eliminated for the Elevated Structure Alternative. In addition to drilled shafts, ground improvement would be performed near the shafts. Impacts due to ground improvement and drilled shafts are discussed in Sections 6.1 and 6.2.1.

6.4.2 Central Area

The Elevated Structure Alternative in the central area consists primarily of a stacked, six-lane elevated structure (three lanes in each direction). The elevated structure would start out with side-by-side lanes at the south end and transition to a stacked configuration near S. Main Street. The alignment of the stacked structure would follow the approximate alignment of the existing viaduct, except between S. Main Street and Yesler Way, where the roadway curve would result in the new structure being shifted partially to the west. Large-diameter drilled shafts would support the elevated structure.

The Elevated Structure Alternative includes the construction of two midtown ramps at Columbia and Seneca Streets. The north end of the new elevated structure would connect to the existing viaduct structure just north of Virginia Street. From this location to the south portal of the Battery Street Tunnel, the existing viaduct would be retrofitted. The Battery Street Tunnel would improve and would be approximately 2 feet deeper than the existing tunnel. The foundation elements would be strengthened by means of footing overlays and micropiles or other means of retrofitting. Ground improvement may be performed in some areas around the existing and proposed foundations.

The Elevated Structure Alternative includes replacing the Elliott Bay Seawall from S. Jackson Street to Broad Street. Between S. Jackson and S. Washington Streets, the seawall replacement would extend along the west side of Pier 48. The seawall would be replaced by improving the ground under the existing relieving platform with the use of jet grouting. A 40-foot-wide corridor that extends to the native soil, typically about 25 to 35 feet bgs, would be improved. The area above the relieving platform would be excavated, and a new L-wall with a cantilever sidewalk would be installed to replace the relieving platform. The area around the L-wall would be filled with compacted select backfill. Near Pier 66, portions of the seawall have already been replaced; therefore, only ground improvement is proposed for these areas.

As described in Section 6.1, jet grouting can produce spoil volumes equal to about 50 to 70 percent of the volume of treated soil. An estimated 20 percent of these spoils would be solids. This spoil material would consist of a blend of eroded soil and cement grout that is flushed to the ground surface during grouting. In addition to having a high pH, the spoils from the fill soil would also likely contain low concentrations of petroleum, PAHs, and metals as discussed in Chapter 4. Groundwater displaced to the ground surface during grouting would also have an elevated pH.

Fill soil would be removed from drilled shafts for the seawall, from below the relieving platform, and adjacent to Alaskan Way to relocate utilities. The excavated fill soil would likely contain localized petroleum and creosote contamination, as well as creosote-treated timbers. Elevated concentrations of metals have also been identified sporadically in fill along the waterfront. Significantly less soil would be excavated for the Elevated Structure Alternative than for either of the tunnel alternatives.

A new precast facing would be installed, and the footing and timbers associated with the existing precast panel wall would be cut at the mudline and removed. This work would occur above the mudline; consequently, no sediment waste should be generated. Impacts due to sediments that could be resuspended are discussed in Appendix O, Surface Water Discipline Report.

Some of the soil ballast above the platform would be excavated. This material, which underlies Alaskan Way, consists of sand and gravel and has a relatively low potential for containing contamination, because after its placement, the soil was immediately covered with the impervious road surface.

As part of the seawall replacement, the waterfront streetcar tracks would be temporarily closed or removed and relocated as required. Shallow soils under the rail would most likely be contaminated with low concentrations of petroleum, primarily lubricating oil and associated PAHs that may have dripped from the trolley or resulted from historical railroad activities.

6.4.3 North Area

The features of the Elevated Structure Alternative in the north area are the same as those of the Cut-and-Cover Tunnel Alternative (see Section 6.3.3).

6.4.4 Battery Street Tunnel Improvements

The Elevated Structure Alternative includes a seismic upgrade of the Battery Street Tunnel similar to the Cut-and-Cover Tunnel Alternative, except that lowering of the roadway at the south portal would not be required to connect to the retrofitted structure. Proposed modifications to the Battery Street Tunnel include constructing new emergency egress facilities, and other improvements. A tunnel maintenance building would be constructed at each end of the Battery Street Tunnel to house maintenance and safety control systems. The lowering of the tunnel walls would require construction of new retaining walls.

Construction impacts would be similar to those indicated for the Cut-and-Cover Tunnel Alternative (see Section 6.3). Subsurface soils may be contaminated with gasoline from gas stations formerly located near the portal.

6.4.5 Viaduct Removal

Under all of the build alternatives, the Alaskan Way Viaduct would be removed. The impacts are described in the discussion of the Bored Tunnel Alternative (Section 6.2.4). Similar to the Cut-and-Cover Tunnel Alternative, all of the debris would require off-site disposal, because the Battery Street Tunnel would be operational.

6.5 Applicable Federal, State, and Local Regulations

Applicable federal and state regulations and policies concerning hazardous materials, potential hazardous waste, and associated liability issues are described in Attachment I. Local regulations are discussed in this section.

Public Health of Seattle and King County is the local regulating agency that oversees compliance with the Solid Waste Handling Standards (WAC 173-350). King County also evaluates the Cedar Hills Regional Landfill, King County landfill, solid waste transfer stations, and stockpiles for compliance. A permit would be required for sites within the county where stockpiles remain more than 90 days. Handling procedures for soil stockpiled for more than 90 days should be tailored to the type of contamination, the level of contamination, and the media. The plan would be reviewed and accepted before King County would issue a permit.

The City also has statutes that pertain to hazardous materials and wastes. These requirements, listed below, take precedence over all other laws for governing business and operations in Seattle, where the requirements are at least as stringent as state or federal requirements.

Seattle Municipal Code, Title 10 – Health and Safety provides the enforcement authority as it relates to the regulation and control of sanitation and disease and other measure to protect the health and safety of the community. The City may investigate any permit holders for compliance.

Seattle Municipal Code, Title 15 – Street and Sidewalk Use includes provisions that relate to use, maintenance, and construction of streets and sidewalks. This code addresses dust suppression requirements during construction and demolition. It also requires the timely removal of excavated soil from streets and sidewalks.

Seattle Municipal Code, Chapter 22.800 – Stormwater, Grading, and Drainage Control Code establishes the City's authority to regulate stormwater within the city limits. The City has published a manual with guidance and mitigation for protecting stormwater quality. Code interpretation is provided in the Seattle Municipal Code in DPD and SPU Joint Director's Rulings. SMC 22.800 (Drainage Code) and a related code**,** SMC 21.16 (Side Sewer Code), regulate the discharge of stormwater and groundwater from dewatering activities to the sewer system. Code interpretation for Side Sewer Permit for Temporary Dewatering is provided in DPD's and SPU's Joint Ruling DPD Director's Rule 3-2004 and SPU Rule 02-04.

Seattle Municipal Code, Title 25 – Environmental Protection and Historic Preservation adopts the uniform requirements of WAC 197-11 for compliance with the Washington State Environmental Policy Act (SEPA) and to establish local procedures and policies where permitted. In particular, environmental health requires assessment for potential exposure to toxic chemicals and mitigation planning. The code also has additional requirements if the site is under an order, agreed order, or decree from Ecology.

Puget Sound Clean Air Agency would enforce regulations regarding discharge to air (including fugitive dust, asbestos, and hazardous chemicals) at the state and local municipality levels.

6.6 Liabilities Associated With Property Acquisition

In acquiring a contaminated property, the agencies could become liable for site cleanup under the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) for non-petroleum-related contaminants and under state law for any type of contaminant. Phase I ESAs conducted to identify potential environmental issues are a standard part of property acquisition. Other standard impacts and mitigation measures addressing liability for a contaminated site are indicated in Attachment J, under the impact type "Acquisition – Cleanup Liability."

The property acquisitions for each alternative are summarized in Exhibit 6-6. Attachment H lists each of the properties that would be acquired or for which permanent or temporary construction easements would be obtained. Included in the easements are temporary and permanent tiebacks. Subsurface parcel acquisition would also be obtained for the Bored Tunnel Alternative.

Exhibit 6-6. Summary of Properties That Would Be Acquired

Sites	Elevated Structure Alternative				Cut-and-Cover Tunnel Alternative				Bored Tunnel Alternative			
	Type of Acquisition				Type of Acquisition				Type of Acquisition			
	Full or Partial	Permanent Tieback or Easement	Temporary CE or TTE	Number of Structures	Full or Partial	Permanent Tieback or Easement	Temporary CE or TTE	Number of Structures	Full or Partial	Permanent Tieback or Easement	Temporary CE or TTE	Number of Structures
South area	6				5				5		3	2
Low	5				5				5		1	
Moderate	1										2	
High												
Central area	9	3	15	2	13	3	9	2				
Low	2	1	15		2	3	9					
Moderate	6				10							
High	1	2			1							
North area	19		1	7	19			7	7	3	2	2
Low												
Moderate	15		1		15				4	3	1	
High	4				4				3		1	
Total sites	34	3	16	9	37	3	9	9	11	3	5	4
Total parcels associated with sites	24	3	9	9	27		9	9	7	3	3	
Parcels not identified as a site	13		6	3	13		11	3		2	1	
Total parcels	37	3	15	12	40		20	12	7	5	4	
Parcels already owned by WSDOT	6				6				5			

Notes: CE = construction easement
TTE = temporary tieback easement

Compensation grouting to improve soil quality and mitigate potential settlement of buildings may be conducted at many of these parcels. Under the Bored Tunnel Alternative, the potential for encountering contaminated soil is much lower on parcels where compensation grouting would be conducted because of the depth of the tunnel and the type of construction. Only parcels on which the crown of the tunnel would be less than 100 feet bgs have been identified as validated sites because soil at these sites may be contaminated (solvents) and compensation grouting could occur from the surface.

For the Bored Tunnel Alternative, all or portions of seven parcels would be acquired. Permanent tiebacks or easements would be acquired on five parcels, and temporary construction easements or tieback easements would be obtained for another four. Subsurface property rights would also be acquired for parcels overlying the bored tunnel. The partial acquisitions would consist of narrow strips through the middle of the block bounded by S. Atlantic Street, S. Royal Brougham Way, First Avenue S., and Alaskan Way S.; at the northeastern corner of the block bounded by Mercer Street and Aurora Avenue; and on the east side of Aurora Avenue at the intersection with Republican Street. Other acquisition parcels include a half block on the east side of Sixth Avenue N. north of Thomas Street, on the east side of Sixth Avenue N. north of Harrison Street, and along the west side of First Avenue S. between S. Royal Brougham Way and S. Dearborn Street. These parcels contain 19 potentially contaminated sites, primarily associated with former railroad operations, metal works, a junkyard, gas stations, and dry cleaners. One additional site (Site 360.1-13) is within the Alaskan Way S. right-of-way and is not associated with any parcel.

The property acquisitions for the Cut-and-Cover Tunnel and Elevated Structure Alternatives would be similar because the alignments would be the same. The exceptions are three parcels south of the Battery Street Tunnel that would be acquired for the transition of the cut-and-cover tunnel to the Battery Street Tunnel would not be needed for the Elevated Structure Alternative. A total of 37 parcels would be acquired for the Elevated Structure Alternative, whereas 40 parcels would be acquired for the Cut-and-Cover Tunnel Alternative. Easements for construction and tiebacks, primarily along the Battery Street Tunnel, would also be obtained for these build alternatives.

For Bored Tunnel Alternative, 4 buildings would be acquired; for the other two build alternatives, 12 buildings would be acquired.

WSDOT has already acquired six parcels, including three parcels on the block bounded by S. Royal Brougham Way, S. Dearborn Street, First Avenue S., and Alaskan Way S. This block encompasses the former Gerry Sportswear property (Site 370.1-1) and the WOSCA property (370.1-2). No sites have been identified on the third parcel. The two parcels directly north of the WOSCA property

(Site 360.15-1) have also been acquired. All of these parcels would be used by the all three build alternatives. A warehouse in the central area (Site 220.2-1), which was formerly a machine shop and auto repair business, is also under WSDOT control and would be used for the Cut-and-Cover Tunnel and Elevated Structure Alternatives.

Little excavation would be required for the Elevated Structure Alternative. To reduce potential liabilities associated with owning the properties, WSDOT conducted a Phase I ESA for Site 360.15, and Phase I and II ESAs were conducted for Sites 370.1-1 (Gerry Sportswear property) and 370.1-2 (WOSCA property).

The southern portion of the study area has been filled, and railroads have operated continuously in the area. The fill was placed around treated and untreated timber piles that supported former railroad tracks and an elevated roadway. Although no specific sites have been identified on some of the blocks, historical railroad activities that typically result in petroleum (e.g., lubricating oil and diesel), PAHs, and metals contamination in near-surface soils and ballast, occurred throughout the study area. Fill in the area is also frequently associated with metals and petroleum contamination. Treated piles and railroad ties would likely be encountered during construction of the tunnel alternatives.

6.6.1 Staging Areas

Numerous potential staging areas have been identified for the build alternatives. (Refer to Chapter 3 of Appendix B, Alternatives Description and Construction Methods Discipline Report, for a description of these sites and their potential uses). Many of the staging areas are located in the industrial areas along the Duwamish River and the waterfront, south of downtown, although there are also several in the north area. Most of the staging areas are paved. If the staging area is contaminated, a paved surface would reduce its potential impact. Many of the sites being evaluated are terminals owned by the Port of Seattle.

The method of transporting spoils from the staging areas has not been identified, but the options include rail, barge, and truck. Management of stockpiled soil would comply with the requirements of state Solid Waste Handling Standards (WAC 173-350). Public Health of Seattle and King County enforces compliance with this regulation on the local level. Spoils handling procedures would be addressed in construction management plans developed for the project, as described in Section 6.8.4 and Appendix O, Surface Water Discipline Report. Please refer to Exhibits G-1 and G-2 for a discussion of staging areas that are within the footprint of a validated site.

6.6.2 Sites With a High Potential Impact

Five sites have been designated as high-impact sites based on their historical land use and proximity to the project area (Exhibit 4-14). Three sites are located in the north area and would potentially be acquired or have temporary tiebacks installed at the site for all of the build alternatives (Sites 50.1-1, Site 50.1-2, and Site 60.3-1). Site 70.4-1, also located in the north area, and Site 150.2-1, located in the central area near the Battery Street Tunnel, would potentially affect only the Elevated Structure and Cut-and-Cover Tunnel Alternatives.

Three of the five sites were laundry/dry cleaners (Sites 50.1-1, 60.3-1, and 70.4-1); one site (Site 50.1-2) supplied dry-cleaning products and laundry dyes; and one site (Site 150.2-1) was a substation (see Attachment G, Exhibit G-2). Solvent contamination from the former dry-cleaning operation has been documented at Site 60.3-1, identified by Ecology as the Vagabond Inn site. A dry cleaner (and a gas station) operated on the property from 1946 to 1957 or 1958, according to information provided by the property owner's environmental consultant. The Seattle Pacific Hotel, a three-story building constructed in 1961, currently occupies the site.

Site 60.3-1 and two adjacent parcels would pose a high potential impact on the project because of off-site contaminants. Site 60.3-1 would be acquired for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. Only a temporary tieback easement would be acquired on Site 60.3-1 for the Bored Tunnel Alternative. The adjacent parcel south of the Site 60.3-1 would be acquired for all of the build alternatives. The adjacent parcel to the west would be acquired only for the Bored Tunnel Alternative north tunnel operations building.

Because the elevation of the ground surface above sea level changes 15 feet within one block, elevation above sea level is a better reference point than depth bgs. Construction of the tunnel operations building would require excavation to a depth of approximately 80 feet bgs (elevation 20 feet) near Thomas Street, but only approximately 60 feet bgs (elevation 25 feet) adjacent to the site. Ecology's file for the Vagabond Inn site shows that during a 1998 investigation (Environmental Associates 1998), solvents were detected in every soil sample collected between the depths of 10 and 60 feet bgs (elevation 25 feet). Solvents were also detected in a groundwater sample collected at a depth of 60 feet bgs. The groundwater was identified as a perched aquifer, with the regional aquifer at a depth of approximately 70 to 80 feet bgs.

Additional investigations of Site 60.3-1 conducted by the owner's consultant (Waterstone Environmental 2000) confirmed the earlier findings and indicated that the highest concentrations of tetrachloroethylene were confined to the parking lot adjacent to Aurora Avenue N. and were contained in a layer of blue clay at a depth of 10 to 30 feet bgs. Contaminant concentrations in soil and groundwater are many orders of magnitude greater than the MTCA Method A cleanup level (concentration of tetrachloroethylene up to 13,000 mg/kg). Soil contamination exceeding the MTCA Method A cleanup levels (0.05 mg/kg for tetrachloroethylene) extends to a depth of at least 50 feet in the center of the site. Contamination has also been encountered at the south end of the site. The northern extent of the contamination appears to be within the parcel boundary. The owner's consultant did not identify the western and southern extent of solvent contamination. Existing data from previous investigations should be evaluated to determine whether the contaminant delineation is sufficient to predesignate soil that would be removed from the site. The eastern part of the site and the parcel south of the site would be part of the widened SR 99 for the Elevated Structure and the Cut-and-Cover Tunnel Alternatives, with excavation extending to an average depth of 30 feet bgs.

In September 2010, WSDOT conducted additional environmental sampling to assess the western extent of contamination from Site 60.3-1. Soil up to 66 feet bgs would be excavated from the adjacent parcel to the west for the construction of the north tunnel operations building associated with the Bored Tunnel Alternative. (Shannon & Wilson 2010d). Additional subsurface data were necessary to develop preliminary cost estimates for soil and groundwater management. Explorations were advanced in the alley west of the site and in parking lots south and southwest of the site. The area and depth of solvent-contaminated soil and groundwater on the adjacent parcels were identified.

Solvents were detected in soil at concentrations less than the laboratory's method reporting limit, but greater than the detection limit in the 2010 investigation. Contaminated soil near Harrison Street at 60 to 45 feet bgs (elevations 25 to 40 feet) would be excavated for the Bored Tunnel Alternative north tunnel operations building. Approximately 100 feet south of Harrison Street, soil from the ground surface to 66 feet bgs (elevation 20 feet), the maximum depth of excavation for the building, was contaminated. Soil south of the site at depths of 45 to 55 feet bgs (elevations 41 to 51 feet) was also contaminated at low levels. This soil may be removed during tieback installations for the Bored Tunnel Alternative and excavated for the other build alternatives.

Shallow perched groundwater was encountered at 18 to 14 feet bgs (elevations 82 to 71 feet). A deeper perched water zone was identified at 43 feet bgs (elevation 42 feet) at Harrison Street and at 50 feet bgs (elevation 46 feet) at the south end of the site. The groundwater gradient beneath the site is 0.025 foot/foot (change of horizontal distance per change of vertical distance) toward the south and southeast. The regional aquifer is encountered roughly 70 to 80 feet bgs (elevations of 17.8 and 15.6 feet) near Sixth Avenue N. between Harrison Street and Thomas Street.

Tetrachloroethylene was detected in the deeper perched water zone at concentrations ranging from 9.3 to 15 μg/L, which are greater than the MTCA Method A cleanup level of 5 μg/L. Contamination was identified in monitoring wells located near Harrison Street and approximately 50 feet south of Site 60.3-1. Solvents were not detected in monitoring wells located on Thomas and Harrison Streets that were completed in the regional aquifer. The perched groundwater removed during construction would require treatment before discharge. The need for dewatering of the regional aquifer adjacent to the site is not expected. The findings are provided as an amendment to the *CT-15 Environmental Considerations Report (*Bored Tunnel Alternative*)* (Shannon & Wilson 2010a). Additional investigation could be required by Ecology before a contained-out designation is granted, as discussed in Section 6.8.5. If the adjacent parcels west and south of the site are acquired, the investigation performed in September 2010 would support the development of the soil management and disposal/construction approach and associated costs. This level of information would likely be necessary for property transfer. The current owner of Site 60.3-1 (Vagabond Inn site, currently Seattle Pacific Hotel) would also be involved in these negotiations because this property is the source of the contaminants.

The Vagabond Inn site (currently Seattle Pacific Hotel) would be acquired for the Elevated Structure and the Cut-and-Cover Tunnel Alternatives. As the new owner of the site, WSDOT would need to limit its potential liability for site contamination and off-site migration that adversely affects adjacent property owners.

Although the Vagabond Inn (Site 60.3-1) would not be acquired for the Bored Tunnel Alternative, a temporary easement would be required. WSDOT could become liable if contaminated soil and/or groundwater removed from either the site or the adjacent parcels is mishandled. WSDOT could also become liable if dewatering alters the existing groundwater plume and makes the existing conditions worse. New areas on the Vagabond Inn site could become contaminated, and/or the contamination could be pulled farther onto the north tunnel operations building property.

On Site 50.1-1, a laundry operated from 1944 through at least 1960. Dry-cleaning operations also occurred at the site. On Site 50.1-2, a laundry dye supply company and a furniture repair business operated. Both of these sites are considered to pose a high potential impact. These sites are located on the block immediately west of Aurora Avenue N. and just south of Republican Street.

The entire block currently owned by the City of Seattle maintenance department (Block 50) should be investigated. The only structure on the block at this time is a shed used by the maintenance department. Two borings (AB-3 and AB-4) were drilled in the Republican Street right-of-way, on the east and west side of Aurora

Avenue N., respectively. In boring AB-3, tetrachloroethylene was detected in three samples collected at 5, 10, and 20 feet bgs, at concentrations of 0.0013, 0.001, and 0.0014 mg/kg, respectively. In boring AB-4, tetrachloroethylene was detected at 0.0011 mg/kg in a sample collected at 2.5 feet bgs. These concentrations are an order of magnitude less than the MTCA Method A cleanup level of 0.05 mg/kg. However, because of the proximity of the borings to Site 50.1-1 and the lack of other nearby solvent sources, it is possible that Site 50.1-1 at the City of Seattle maintenance yard is the source of the tetrachloroethylene encountered in the right-of-way.

Investigations at Sites 50.1-1 and 50.1-2 and are needed to determine whether contamination is present and to delineate the extent of the contamination. Depending on the complexity of the subsurface conditions and the soil management and disposal options that could be implemented, additional investigations may be necessary, as described in Section 6.8.2. Mitigation measures that could be used to manage the solvent-contaminated soil are discussed in Section 6.8.5.

Construction is unlikely to make existing in situ conditions worse. The deepest excavation would be above the regional water table, so dewatering of this water-bearing unit would not be required. Dewatering of perched water may alter groundwater flow patterns; however, perched water zones do not appear to be laterally extensive.

A dry cleaner/laundry operated on Site 70.4-1 from about 1938 until 1959, at which time a motel was constructed on the property. No site investigation has been conducted. Soil and groundwater could be contaminated with solvents. Before property transfer occurs, a site investigation should be conducted to determine whether contamination is present. The current property owner would be responsible for remediation the site. If the site is contaminated, proper management and disposal options for contaminated media would be evaluated.

Site 150.2-1, a former substation, would be acquired for the Cut-and-Cover Tunnel and the Elevated Structure Alternatives. The substation operated from 1958 through at least 1980. The site is currently a parking lot and is still owned by Seattle City Light. No site investigation has been performed. Based on nearby explorations, multiple discontinuous perched water zones may exist between approximately 10 and 55 feet bgs. Soil and groundwater could be contaminated with petroleum and PCBs. Before property transfer occurs, a site investigation should be conducted to determine whether contamination is present. If the site is contaminated, proper management and disposal options for contaminated media would be evaluated.

6.7 Worker Safety and Public Health and Safety Concerns

Issues related to worker safety and public health and safety pertain to potential exposures to pollutants, hazardous materials, and wastes encountered or generated during construction activities. Physical hazards associated with construction activities are not addressed. Standard impacts and mitigation measures are discussed in Attachment J.

LBP has been found in the Battery Street Tunnel and may be present in other parts of the viaduct. Under WAC 296-155-17607, an employer must ensure that no employee is exposed to lead at concentrations exceeding the permissible exposure limit of 50 micrograms per cubic meter. The employer can meet that requirement (assuming lead is present in some elements of the viaduct) by conducting an initial exposure assessment. Employers that have completed a certain number of roughly equivalent projects in the past year could use the data to show that the initial exposure assessments used for other projects would be applicable to the current project, and use the same level of personal protective equipment.

The requirements of WAC 296-62-077 specify that building owners must identify and dispose of ACM that may be encountered during demolition or renovation activities. This requirement is also in PSCAA Regulation III, Section 4.02, Asbestos Survey Requirements.

The AHERA regulation (40 CFR 763) is the primary governing regulation for performing asbestos surveys. AHERA defines suspect ACM and specifies the minimum number of samples to be collected and analyzed from a suspect material. AHERA was originally enacted for school buildings, but since 1994 the Asbestos School Hazard Abatement Reauthorization Act has applied to public and commercial buildings. The Occupational Safety and Health Administration and the Washington Industrial Safety and Health Act worker protection regulations, specifically 29 CFR 1926.1101(k) and WAC 296-62-077, have also incorporated AHERA for demolition and renovation projects.

Other chemical hazards would be addressed in a site-specific health and safety plan that identifies potential chemical hazards for the various work activities. The plan would identify appropriate monitoring and threshold values that would trigger additional protective actions, including an increase in the level of personal protective equipment, monitoring, engineering controls, and changes in work flow.

In areas of known contamination, site workers would need to have Hazardous Waste Operation and Emergency Response training (40-hour HAZWOPER Certification [29 CFR and WAC Chapter 296-843]). This training is designed for workers engaged in hazardous substance removal or other activities that expose or potentially expose them to hazardous substance and health hazards. An annual 8-hour refresher course is also required.

In addition to standard impacts, a dry cleaner site (Site 60.3-1) at the north portal presents some unique concerns related to worker safety and public health and safety. Appropriate controls must be put in place, and personnel protective equipment must be worn to address exposure to solvent-based contamination during excavation activities.

Ecology would regulate the handling and disposal of the solvent-contaminated material from sites that have been used for dry-cleaning operations. Preparation of a site-specific CSMP would be required to address these issues before any excavation occurs. Ecology would review the plan, as it pertains to contained-out waste.

6.8 Construction Mitigation

This section discusses mitigation for the construction effects related to hazardous materials and handling and disposal options for hazardous materials. The alternatives have been designed to avoid contamination where possible and to minimize handling and disposal activities to the extent feasible where contaminated material cannot be avoided.

Mitigation measures that would be required as part of the construction planning include the development of a temporary erosion and sediment control plan; a spill prevention, control, and countermeasures plan; a CSMP that addresses handling and disposal of known and unanticipated contamination; a fugitive dust control plan for dust-generating activities; and a water quality monitoring plan. In addition, a dewatering plan would be required to delineate any necessary treatment and discharge of dewatering water to the storm and combined sewer, in accordance with the requirements of King County's Industrial Waste Discharge Permit. WSDOT Standard Specifications and necessary regulatory permits, including the National Pollutant Discharge Elimination System (NPDES) stormwater permit, would require development and implementation of these plans. These mitigation measures as well as other standard mitigation measures are described in Attachment J.

6.8.1 Data Gaps and Unknowns

General information from readily available sources was used to generate the histories of properties within the study areas. Uses at individual sites that could have resulted in contamination may not be indicated in the available information.

It is assumed that the risk of contamination from businesses that use, store, or dispose of hazardous materials increases with the length of time the businesses were in operation. The length of time particular businesses were in operation was not necessarily indicated by the available data, limiting the ability to ascertain this risk.

6.8.2 Recommendations for Further Investigations

This section outlines the approach for mitigating potential risks associated with hazardous material sites and provides recommendations for specific activities that should be undertaken. WSDOT has already conducted some of these activities in preparation for the project. As part of WSDOT's due diligence, Phase I ESAs have been conducted for all properties that have been acquired for the project. Phase I ESAs will be conducted for any additional parcels that would be acquired.

WSDOT has also conducted Phase II ESAs and other investigations to evaluate the potential presence and distribution of contaminants. Surveys to identify ACM, LBP, or other hazardous materials have been conducted for the Battery Street Tunnel (see Section 3.7). Geophysical surveys may be conducted to identify subsurface conditions that could relate to hazardous materials, such as USTs or buried drums.

Investigations should be conducted for sites that would be acquired or have a significant potential to affect the project. Recommended investigations for each alternative are summarized in Exhibit 6-7. Recommended investigations for each site or parcel are summarized in Attachment H, Exhibits H-1, H-3, and H-4.

Site Reconnaissance Recommendations

A full-access site reconnaissance is recommended for all properties where a temporary or permanent easement would be obtained. Reconnaissance should also be conducted on all acquired properties, although a site visit is typically included in a Phase I ESA. Some parcels with easements are also identified as validated sites, while others have no historical land use associated with hazardous materials. The recommended investigations are indicated by site and parcel in Exhibit 6-7. The reconnaissance should be conducted by experienced environmental professionals and, wherever possible, include interviews with persons knowledgeable about present and past operations at the site.

Exhibit 6-7. Summary of Recommended Investigations

Type of Investigation	By Site			By Parcel		
	Elevated Structure Alternative	Cut-and-Cover Tunnel Alternative	Bored Tunnel Alternative	Elevated Structure Alternative	Cut-and-Cover Tunnel Alternative	Bored Tunnel Alternative
Parcels With a Validated Site						
Reconnaissance (for easement)	14	12	8	10	9	2
Phase I ESA	27	30	8	22	25	5
Phase II ESA	30	33	13	24	27	5
Focused Phase II ESA for easement	14	12	8	10	9	2

Exhibit 6-7. Summary of Recommended Investigations (continued)

Type of Investigation	By Site			By Parcel		
	Elevated Structure Alternative	Cut-and-Cover Tunnel Alternative	Bored Tunnel Alternative	Elevated Structure Alternative	Cut-and-Cover Tunnel Alternative	Bored Tunnel Alternative
ACM/LBP survey	10	10	4	10	10	4
Geophysical survey	7	6	1	5	4	1
Contaminant delineation	1	1	1	1	1	1
Parcels With No Validated Site						
Reconnaissance (for easement)				6	11	3
Phase I ESA (partial or full acquisition)				13	13	
ACM/LBP survey				3	3	
Parcels Already Owned by WSDOT						
ACM/LBP survey				1	1	1

Notes: For site-specific investigations, see Attachment H, Summary Tables of Property Acquisitions.
ACM = asbestos-containing materials
ESA = environmental site assessment
LBP = lead-based paint

Phase I ESAs

Phase I ESAs should be conducted for properties that would be acquired as part of due-diligence requirements and WSDOT guidance. Although this document addresses many of the requirements of a Phase I ESA conducted in accordance with ASTM 1527, additional RECs could be identified. Phase I ESAs have already been conducted for some of the parcels that would be acquired, as described in Section 3.7. WSDOT will conduct Phase I ESAs for any additional parcels that would be acquired.

Phase II ESAs

For total or partial property acquisitions, Phase II ESAs are recommended for properties where RECs associated with historical land use have been identified during the initial Phase I ESA. Decisions relating to acquisitions consider whether WSDOT's need for or benefit from owning the property would be offset by the potential cost and risk of owning a known contamination source and taking responsibility for the resulting property contamination. In addition, site investigations should target potential contaminants associated with historical land use for that portion of the parcel. Site investigations would be coordinated with the property owner.

Focused Phase II ESAs may be warranted for parcels where WSDOT would obtain temporary or permanent easements. Easements may be obtained for construction activity or the installation of temporary or permanent tiebacks. In some instances, a validated site has been identified on the parcel. The property should be evaluated for the type of construction activity that would occur. A site investigation could determine whether spoils from tieback installations could be contaminated, or it may establish baseline subsurface conditions for the parcel.

Borings with environmental sampling are recommended (within the WSDOT right-of-way) for properties located adjacent to the project footprint in the south and north areas on which contaminants may be encountered during construction activities (e.g., excavation, ground improvement, installation of drilled shafts, and dewatering). Sampling for VOCs is also recommended for sites where the crown of the tunnel would be less than 100 feet bgs. Potentially contaminated adjacent properties that pose a high enough risk to warrant sampling include sites where it is known or suspected that contamination extends into the right-of-way and any sites where the most likely potential contaminants are chlorinated solvents. Such contaminants have a tendency to be highly mobile and may present a hazard to activities on other properties. As described in Section 3.8, environmental sampling was coordinated with explorations conducted for the preliminary design of the project. To the extent practicable, geotechnical borings were placed to evaluate whether contaminants are present. Environmental testing was conducted based on the current or historical land uses of nearby properties.

Explorations to obtain soil and groundwater samples could be conducted with direct-push-type equipment, such as a Geoprobe® machine. Drilling would be necessary where obstacles prevent Geoprobe® advancement or where the subsurface interval of interest is greater than 30 feet bgs.

The Phase II ESAs recommended for each of the alternatives are summarized in Exhibit 6-7. Recommendations for the individual sites are indicated in Attachment H. Exhibits H-1 and H-3 include the primary contaminants, planned construction, impact, remediation, and recommended type of investigation. Phase II ESAs have not been recommended to characterize fill and general railroad activities; however, environmental testing was conducted during the design phase to characterize the fill, as described in Section 3.8. Additional investigations should be performed that are appropriate to the level of risk associated with the RECs identified in the Phase I ESA. Phase II ESAs have already been conducted at the WOSCA property (Sites 370.1-1 and 370.1-2). Data generated from explorations (deep borings) for engineering design could provide sufficient data in other portions of the project area. In addition, environmental data collected from geotechnical borings drilled in areas of tiebacks may be sufficient to characterize material that would be removed during construction. The data from all of these explorations for the Bored Tunnel Alternative are summarized in the *CT-15 Environmental Considerations Report* (Shannon & Wilson 2010a). Similar information is included in an environmental considerations report that was prepared for the other build alternatives (Shannon &Wilson 2005b).

Additional Investigations

Site characterization or more extensive investigations may be necessary to collect subsurface data. Phase III ESAs and or additional environmental investigation to delineate contamination may be necessary for sites that would be acquired, particularly if the Phase II ESAs indicate the presence of contamination on the site. Phase III ESAs may involve additional sampling, monitoring, fate and transport studies, and other modeling to evaluate how and where contaminants have moved; and feasibility studies for material handling and management plans. The information may be used to develop preliminary cost estimates for proper management and disposal of the contaminants.

At the Vagabond Inn site (Site 60.3-1), a property where a dry-cleaner operated, extensive sampling has been completed by the property owner. The site is currently occupied by the Seattle Pacific Hotel. A "hot spot" of solvent-contaminated soil has been identified in the eastern part of the site. With the Bored Tunnel Alternative, the tunnel operations building at the north portal would be located on the adjacent parcel to the west and south. During the preliminary design phase, explorations were advanced on WSDOT right-of-way on Aurora Avenue N., Sixth Avenue N., and Thomas and Harrison Streets. Very low concentrations of tetrachloroethylene and/or breakdown products were identified only in shallow soil samples collected in the Aurora Avenue N. right-of-way, adjacent to the Vagabond Inn site.

In September 2010, WSDOT conducted additional environmental sampling to assess how the western extent of contamination from Site 60.3-1 would affect construction activities within the project area (Shannon & Wilson 2010d). Buildings occupy the Vagabond Inn site and the adjacent parcel to the west, and numerous utilities cross the area. Therefore, explorations were advanced in the alley between the parcels and in the parking lots south of the buildings. Contaminated soil and perched groundwater were encountered west of the site as described in Section 6.6.2, Sites with a Potential High Impact. Findings from this exploration effort were used to determine whether soil excavated for the Bored Tunnel Alternative north tunnel operations building would qualify for a contained-out designation. Handling and disposal requirements for soil with a contained-out designation are indicated in Section 6.8.5.

Ecology may require additional investigation before granting approval for a contained-out designation; however, to be cost effective the investigation should occur after the existing building is demolished. At this stage, a conservative volume of soil has been identified as contained-out. If Ecology accepts the current level of investigation, additional investigation on the parcels south and west of the site may be of little benefit. The cost of the investigation would need to be weighed against the potential reduction in disposal costs if the soil is classified as clean. Existing data from previous investigations conducted on the site for the owner should be evaluated to determine the current contaminant distribution. If there are sufficient data to predesignate the soil, additional delineation would not be required to dispose of the soil that would be removed during the installation of tiebacks.

The Vagabond Inn site would be acquired for the Elevated Structure and Cut-and-Cover Tunnel Alternatives. Predesignation of solvent-contaminated soil classified as dangerous waste and contained-out waste and identification of clean soil would likely be required by Ecology before soil in the eastern part of the site could be excavated. Remediation of this site would not be the responsibility of the project. If solvent contamination is confirmed at another site where a dry cleaner operated, then a similar process would be required. A dry-cleaning operation was located one block north (the current City of Seattle maintenance yard). The lateral and vertical extents of contamination and the concentrations of the dry-cleaning solvents would need to be determined. Additional characterization may also be necessary to delineate potential petroleum contamination associated with the former auto repair business.

Asbestos-Containing Materials and Lead-Based Paint Surveys

Surveys for ACM and LBP are recommended for buildings that would be acquired. Buildings constructed before 1977 are more likely to contain ACM and LBP, as discussed in Section 3.6. Recommendations for surveys are indicated in Exhibit 6-7. If additional buildings would be acquired, they would also need to be similarly evaluated. Surveys are also necessary to obtain a demolition permit from the Seattle DPD.

ACM, LBP, and lead-containing soot have already been identified in the Battery Street Tunnel (Pacific Rim Environmental 2008; Taylor 2007). Other sections of the Alaskan Way Viaduct may need to be surveyed before demolition.

Geophysical Surveys

Applicable geophysical methods for locating USTs include ground-penetrating radar, electromagnetic methods, metal detection, and magnetometry. Ground-penetrating radar uses high-frequency electromagnetic waves to obtain subsurface information. Objects such as tanks and pipes deflect the waves. However, because of debris, including rebar in concrete that can interfere with the signal and wet clay soils that can absorb the waves, the depth of penetration is typically limited to between 3 and 15 feet bgs. Often other subsurface debris creates anomalies that mask the presence of tanks.

Electromagnetic methods refer to subsurface conductivities by low-frequency electromagnetic induction. Buried objects and objects above the ground surface, such as overhead power lines, fences, vehicles, and buildings, also can interfere. The difference between the conductivity of the UST and that of the surrounding fill material is typically enough for detection.

Metal detectors can locate buried metal objects. There are two types of metal detection: frequency domain and time domain. Frequency domain detection is applicable for identifying shallow buried metal objects, such as pipes. Time domain detection can identify objects up to 15 feet bgs. Metal detectors are similar to electromagnetic methods, but they are modified to locate metal objects. When the subsurface current is measured at a specific level, the metal is identified by meter reading and/or with a sound. Depending on the size of a tank, it can be detected at a depth of up to 20 feet bgs. Smaller metal objects have to be much closer to the surface to be identified. This method is also sensitive to interferences from other metal objects such as vehicles, buildings (with rebar), and buried pipes.

Magnetometers work by measuring the earth's total magnetic field at a particular location. Buried ferrous materials distort the magnetic field, creating a magnetic anomaly. However, because of abundant interference at urban sites (e.g., by material such as concrete with rebar, utilities, and vehicles), this method is not widely used for UST identification.

Exhibits H-1 and H-3 in Attachment H summarize the number of geophysical surveys that may be necessary for each of the build alternatives. Former locations of gas stations that are recommended for geophysical surveys are also identified in Attachment H. Although these surveys are not always conclusive, it would be a first step in identifying USTs. Current property owners of these sites should be contacted for properties that would be acquired. They may have knowledge or documentation of tank status and locations. For the Bored Tunnel Alternative, three sites in the south area may have USTs. Temporary tiebacks would be installed at these sites. The width of the temporary construction easement may influence the determination of whether a geophysical survey is warranted. In the north area, one site identified as a property with a former gas station would be acquired. Part of the original site was acquired for the construction of Broad Street. A portion of the parcel remains.

Additional Investigation Costs

Additional investigations to determine whether contaminants or other hazardous materials are present at a site are standard mitigation measures. Typical costs and time for completion are summarized below:

Phase I ESA	$3,000–$8,000	4–8 weeks
Phase II ESA	$15,000–$30,000	8–12 weeks
Phase III ESA	25,000–$100,000	12–16 weeks
Asbestos survey	$3,000–$10,000	2–4 weeks
Lead survey	$1,000–$2,000	2–4 weeks
Geophysical survey	$500–$3,000	2–4 weeks

6.8.3 Avoidance of Effects

In addition to avoiding the acquisition of contaminated properties, there are various means of reducing potential liability, including but not limited to the following:

- Leasing rather than purchasing property
- Obtaining a surface easement rather than purchasing property
- Creating an indemnification agreement and/or prospective purchaser agreement with the current property owner
- Valuing property as clean and placing funds in escrow until cleanup is completed by the owner

Specific mitigation measures have been identified for the properties that would have a high potential impact on the project (Sites 70.4-1, 60.3-1, 50.1-1, 50.1-2, and 150.2-1). Solvents potentially contaminate four of these sites, and PCBs may be present on the fifth site.

Three separately owned parcels are associated with Site 60.3-1, the Vagabond Inn site (currently the Seattle Pacific Hotel). For the Cut-and-Cover Tunnel and Elevated Structure Alternatives, the site and the adjacent parcel to the south would be acquired. For the Bored Tunnel Alternative, a temporary construction easement for temporary tiebacks would be acquired for Site 60.3-1. The adjacent parcels to the south and west would be acquired. The tunnel operations building at the north portal for the Bored Tunnel Alternative would be constructed on the parcel to the west, which would not be acquired for the other build alternatives.

If Site 60.3-1 is acquired (proposed for the Cut-and-Cover Tunnel and the Elevated Structure Alternatives), the current site owner would need to be identified as the responsible party for cleanup of the site and adjacent parcels. The current owner has already established that excavation is the only remediation method that would be effective for the "hot spot."

Based on the investigation performed by WSDOT in 2010, contamination appears to extend to the property on which the north tunnel operations building for the Bored Tunnel Alternative would be constructed (west of Site 60.3-1). Site cleanup would be responsibility of the current owner, who would negotiate with the owner of Site 60.3-1. Contaminated soil would be disposed of as described in Section 6.8.5. Obtaining a surface easement or leasing the property is not a viable option, because substantial portions of this block would be excavated for the north tunnel operations building.

A similar approach could be taken for the adjacent parcel south of Site 60.3-1, which would be acquired for all of the build alternatives. The western portion of the parcel would be excavated for the Cut-and-Cover Tunnel and Elevated Structure Alternatives.

Sites 50.1-1 and 50.1-2 are currently part of the City of Seattle maintenance yard. The City is a co-lead agency for this project. Substantial portions of this parcel would be excavated for all of the build alternatives.

Site 150.2-1, the former substation owned by Seattle City Light, would be acquired for the Cut-and-Cover Tunnel and Elevated Structure Alternatives. Excavation may occur on the site, which is located at the south end of the Battery Street Tunnel.

6.8.4 Minimization of Effects

Phase II ESAs should be performed in areas where excavation or drilling is expected to facilitate the development of a plan for contaminant management during construction. Where construction in a contaminated location cannot be avoided, the construction methods could be adjusted to minimize the amount of contamination that may be encountered. Other methods that mitigate the effect of spoils include appropriate waste designations for spoils, handling and disposal procedures that minimize spoils handling, and identification of adequate laydown areas for spoils.

Contaminated Spoils

Contamination would likely be encountered during earthwork. Soil contaminated with petroleum (primarily oil-range) or creosote and creosote-treated timber would likely be encountered at the south portal. Wood waste within the bored tunnel alignment would require special handling, and gasoline and solvents would likely be encountered at the north portal. Exhibits 6-1 through 6-5 summarize the estimated volumes of soil that would be removed, including the estimated volumes of material that is potentially contaminated. If there is sufficient space to stockpile soil and it is financially beneficial, the contractor may segregate excavated clean soil, soil contaminated at low levels (Class II), and soil that is contaminated at levels exceeding the MTCA cleanup levels but not considered dangerous waste (problem waste). Confirmation sampling may be required by the disposal facility to verify that the excavated soil has been assigned to the correct soil disposal category. If confirmation samples are not required, soil disposal would be more expedient. However, the soil may be assigned to a more conservative soil disposal category if the data are insufficient to clearly identify the appropriate soil disposal category. The costs for sampling would be less; but the disposal costs would likely be higher, assuming that disposal costs at a RCRA Subtitle D landfill would be greater than fees charged by land reclamation facilities.

Four land reclamation facilities that accept contaminated soil with detectable concentrations of contaminants less than the MTCA Method A cleanup level (Class II) have been identified. The soil must also have a pH greater than 6.5 and less than 8.5. The limits are based on each facility's permit, as described in the *Draft Spoils Handling and Disposal Planning Report* (PB 2009b). At a land reclamation facility, the acceptance criteria for petroleum may be more restrictive than the MTCA Method A cleanup levels. Two RCRA Subtitle D landfills accept all levels of contaminated soil and pH, as long as it is not considered a dangerous waste. Dangerous waste must be disposed of at a RCRA Subtitle C landfill. If Ecology has provided a contained-out designation for solvent-contaminated soil associated with a dry-cleaning operation, the soil can be disposed of at a RCRA Subtitle D landfill.

A CSMP would be developed for soil removed during project construction. The plan would address handling and disposal of soil in the five soil disposal categories. If soils encountered during project construction are expected to be a dangerous waste (i.e., contaminant concentrations exceeding the state criteria for disposal at a RCRA Subtitle D landfill), an identification number could be obtained and planning for soil handling and disposal could be completed before construction. This would reduce the soil handling time, because soils could be loaded onto trucks during initial excavation and hauled directly to treatment or disposal facilities. The disposal facility may require additional testing before accepting the material, which could delay spoils disposal.

Handling and disposal procedures for solvent-contaminated soil associated with a dry-cleaning operation would be site-specific. Handling of soil and groundwater affected by dry-cleaning operations would be regulated by Ecology. Once site characterization is completed, it may take 1 to 3 months to obtain a contained-out designation from Ecology. Soil would be hauled directly to the RCRA Subtitle D landfill, reducing costs and potential exposure to solvent-contaminated soil. Confirmation samples may be required by the disposal facility.

Adequate space for stockpiling is necessary so that the excavation can proceed on schedule. Based on engineering estimates, the staging area(s) should be capable of storing approximately 25,000 cy of spoils. Excavation could be required in contaminated areas not previously identified. A stockpile area could be designated for temporary storage of soils until the characterization results are available.

Spoils volumes vary by construction method. Alternative methods that generate less spoils may be appropriate in areas of known contamination. Drilled shafts result in spoils as the soil is brought to the surface. Driven piles on the other hand displace soil laterally and do not generated spoils. Other construction effects; however, may prohibit the use of a particular method. Pile driving would result in unacceptable levels of noise and vibration in much of the project area.

The slurry used in diaphragm wall construction can be reused, after the solids are removed. The slurry can also become contaminated if the wall is installed in contaminated soil. To reduce the potential for slurry contamination, the contaminated portion of the hole could be cased, to a maximum practicable depth of about 50 feet. If the slurry becomes contaminated, it could be reused within the contaminated zone on the property (if the contaminant concentrations are less than the MTCA Method A cleanup levels). The generated volume of contaminated slurry could be minimized by constant reuse through the contaminated zone. At the end of the contaminated area, it should be disposed of appropriately to minimize cross-contamination along the diaphragm wall. If the contaminated slurry is not reused, it would be disposed of at a facility that can accept it.

Ground freezing could also be used to improve tunneling the behavior of in situ soils and reduce adverse effects on the existing viaduct. It would be an alternative to jet grouting. This method could be used during excavation in the south area, and it would temporarily alter groundwater flow. However, permanent watertight barriers would still be necessary in the south area for the tunnel operations building and the cut-and-cover tunnel. Ground freezing is typically accomplished by recirculating refrigerant fluid through a closed-loop system of casings and header pipes that includes a heat exchanger/cooling plant, or by pumping expendable refrigerants into the casings, such as liquid nitrogen or carbon dioxide. Freezing systems must be properly designed according to the soil and groundwater conditions.

Contaminated Groundwater

Dewatering would be necessary during construction of the retaining walls for the cut-and-cover tunnels and during the deep excavations for the tunnel operations buildings (for the Bored Tunnel Alternative) and the tunnel maintenance buildings (for the Cut-and-Cover Tunnel Alternative). Groundwater is 2 to 12 feet bgs in the south portal area, necessitating extensive dewatering efforts. In contrast, groundwater in the north end of the project area is perched, and the regional groundwater is 70 to 80 feet bgs. Therefore, large-scale dewatering is not expected to be necessary in the north area. Dewatering water would be handled and discharged to meet applicable local, state, and federal requirements.

Effects from construction dewatering would be mitigated by implementation of the stormwater pollution prevention plan; the temporary erosion and sediment control plan; and the spill prevention, control, and countermeasures plan (discussed in Appendix O, Surface Water Discipline Report). Measures described in these plans should include the treatment of water generated by the dewatering of shallow groundwater areas before discharge. Groundwater removed from deeper soil units is less likely to contain contaminants. Water quality treatment for shallow dewatering could consist of storing the water to allow particles to settle or reducing suspended particles by adding chemical flocculants (i.e., chemicals that promote flocculation by causing colloids and other suspended particles in liquids to clump together into a mass, called a *floc*). Any water with contaminant concentrations greater than the thresholds would require treatment to acceptable standards (King County Wastewater Discharge Permit or Authorization conditions) before being discharged to the sewer system or disposed of at an approved off-site disposal facility.

Given the rates of pumping for dewatering water in some areas, detention of this water may be necessary before discharge to either the storm drainage system or the combined sewer system to meet the requirements of the King County Wastewater Discharge Permit or Authorization and to avoid overwhelming these conveyance systems. Depending on the volumes and timing, if discharge of dewatering flows to the stormwater or combined sewer system is infeasible, off-site disposal would be required.

Temporary storage and treatment areas would be identified as part of the dewatering plan. The size and configuration of the areas would also be determined.

Specific construction methods may be necessary to prevent cross-contamination and to minimize the migration of hazardous materials or contaminated media during construction. In areas of known groundwater contamination, special drilling methods would be used to reduce the potential for vertical migration of contaminants during the installation of the drilled shafts and dewatering wells. Each saturated zone would be cased to prevent groundwater from entering the borehole and flowing down the open shaft. Dewatering wells should be designed to minimize drawdown and the area of influence to reduce the potential for mobilizing contaminants that may be present in the groundwater.

Lateral support would be required for cut-and-cover tunnel construction. Although soldier piles with tiebacks and/or soil nails could be used, they would extend the project boundaries beyond the tunnel footprint. Other lateral support approaches, such as drilled shafts, would provide waterproof support systems that would eliminate or reduce the production of contaminated groundwater.

Solvent-contaminated groundwater at the north portal area would require containment before discharge. The water could be placed in Baker tanks. Treatment could occur on site or off site and could be accomplished by passing the water through a GAC filter to remove organic contaminants. Testing after treatment would be necessary to confirm that the solvents were removed.

H_2S has been encountered within the project area. Appropriate H_2S treatment options would depend on the concentration of H_2S. Trace amounts of H_2S (up to a few tenths mg/L) can be filtered such that the H_2S is adsorbed onto the carbon surface before discharge. In this method, the filter must be replaced when it is exhausted and cannot be recharged.

Aeration (adding air to the water) is an appropriate treatment method for H_2S at concentrations less than 2 mg/L. In any aeration system, the water must be protected from bacterial contamination and freezing, and there are large space requirements. Another limitation of this method is that the aeration process produces a strong, potentially unpleasant H_2S odor near the aerator. Furthermore, this process by itself may not always reduce the H_2S to the required levels. However, the addition of a carbon filter may remove some of the remaining trace amounts of H_2S.

An iron-removal filter containing manganese greensand is appropriate for H_2S at concentrations of 1 to 10 mg/L. Manganese dioxide oxidizes H_2S, and the oxidized particles are then filtered out in the lower part of the bed. This type of filter must be recharged with a solution of potassium permanganate when the manganese greensand is depleted. Water with a pH less than 6.7 may require treatment with an acid water neutralizer before this process will be effective.

For H_2S concentrations greater than 6 mg/L, the most common treatment method is constant chlorination using an automatic chemical feed pump. The recommended dosage of chlorine is 2 mg/L for each mg/L of H_2S. The chlorine should be added ahead of the mixing tank, and sufficient storage must be provided to maintain 20 minutes of contact time between the water and the chemical.

Groundwater Flow

Dewatering would be necessary during construction of the cut-and-cover tunnels, retaining walls, and deep excavations for the tunnel operations buildings. To the extent feasible, the dewatering systems required for construction should be designed to minimize drawdown of the water table, which would reduce the volume of groundwater requiring treatment and disposal. It would also reduce the potential for mobilization and spreading of groundwater contaminants toward the project area.

Because of concerns about ground settlement, water would need to be reinjected close to where it is removed. Placement of the pumping wells and the reinjection points can be evaluated to minimize gradients near areas of groundwater contamination. In addition, the reinjection wells can be placed to create a hydraulic barrier for contaminated groundwater.

Jet grouting and DSM could be performed to allow permeable zones for groundwater to flow through the area after the ground improvements are completed. Although groundwater flow paths would be altered, this approach would avoid a large-scale groundwater diversion and would reduce the potential for contamination of crossgradient properties.

Mitigation for groundwater mounding is described in Section 5.2.4. Placement of pipes or drainage trenches would take into account the characteristics of contaminant plumes so as not to make the existing conditions worse.

Airborne Contaminants

VOCs, including compounds from creosote-treated timbers, gasoline-contaminated soil, and dry-cleaning operations, could become airborne during construction. Air monitoring can be performed, if conditions warrant it, and best management practices and/or engineering controls would be used so that VOC emissions are less than the relevant criteria, including those of the Washington State Department of Labor and Industries and PSCAA.

To reduce the effect of dust and odors during excavation activities, the work areas could be covered, or the amount of active work surface that is open could be reduced. Engineering controls could also be implemented, such as wetting of surfaces with water or polyacrylamide blends that bind soil to prevent it from becoming airborne, ventilation with fans to dissipate volatile contaminants, and air filtration methods to remove particulates and volatile compounds. Work associated with the project would be planned to control fugitive dust during construction, according to an existing agreement between WSDOT and PSCAA.

ACM and LBP could become airborne during demolition activities. To minimize this potential, a survey by an AHERA-certified building inspector would be conducted in advance of demolition. If asbestos is present at levels above the criteria, abatement work to remove the ACM would be necessary. LBP is primarily addressed by minimizing dust-generating activities in identified areas. Air monitoring can be performed in areas of concern, and work practices can be modified accordingly. Regulations that address ACM and LBP are discussed in Section 6.7.

6.8.5 Contaminated Media Handling and Disposal Options

Contaminated soil and groundwater have been identified within the project area. Potential contaminants include petroleum hydrocarbons, metals, PCBs, VOCs, and semivolatile organic compounds. In addition, buildings that may contain ACM and LBP would be acquired for all of the build alternatives. Soil, groundwater, and building debris should be disposed of in the appropriate manner and in accordance with regulations and permits that would be issued for the project.

Mitigation Options for Contaminated Soil and Groundwater

Contaminated soil and groundwater can be associated with commercial and industrial operations. Commercial operations in the project area include but are not limited to gas stations, auto repair shops, laundries/dry cleaners, printers, photo developers, and paint removal companies. Industrial operations include metal fabricating and plating works, railroad operations, and junkyards. In addition, fill may be contaminated from unknown sources. Soil characterization has been performed to identify potential disposal options. Groundwater sampling has also been performed to assess the presence, distribution, and concentrations of contaminants in groundwater. The mitigation options for contaminants differ depending on the contaminated media; mitigation for soil and groundwater containing contaminants is discussed below.

Contaminated Soil

Five categories of soil have been identified for disposal, as described in Section 6.2:

- Clean soil
- Class II impacted soil
- Problem waste
- Dangerous waste
- Contained-out waste

Special handling is required for dangerous waste and contained-out waste. Soils with contaminant concentrations exceeding the TCLP criteria or other dangerous waste criteria would require handling as Washington State dangerous waste (WAC 173-303).

Contaminated soil removed from a property (as waste) that is known to be from a dry-cleaning operation is regulated under the state dangerous waste rules (WAC 173-303), which incorporate the requirements of RCRA. Ecology allows the disposal of soil contaminated with low concentrations of dry-cleaning solvents at a RCRA Subtitle D landfill if the soil has been classified as contained-out waste.

Ecology may require 1 to 3 months to review the data and issue a contained-out designation.

A contained-out designation means that tetrachloroethylene and its breakdown products are present (contained) in the waste at concentrations that are less than the established risk-based criteria. The concentrations of tetrachloroethylene and its breakdown products must be less than their respective MTCA Method B criteria. At concentrations greater than these criteria, the soil would require disposal as dangerous waste at a RCRA Subtitle C landfill. In addition to the specific dangerous waste designation for solvents from a dry cleaner (F002), a TCLP result may be required to determine whether the spoils exceed the tetrachloroethylene characteristic dangerous waste criterion of 0.7 mg/L.

Site characterization to determine the lateral and vertical limits and distribution of contaminant concentrations is necessary to address Ecology's criteria for a contained-out designation. WSDOT has conducted additional environmental sampling to determine whether soil that would be removed for construction of the north tunnel operations building associated with the Bored Tunnel Alternative would qualify for a contained-out designation, as described in Section 6.6.2. A written request for the designation must be submitted to the Ecology Northwest Regional Office Hazardous Waste Toxics Reduction Program. The request must include an estimate of the volume of contaminated soil for which a determination is sought, representative analytical data obtained during the site characterization, and a diagram showing the location of the soil. The request must also include a plan that describes the intended handling and transportation methods and identifies the final disposal site. In 2010, WSDOT evaluated soil and groundwater near the north tunnel operations building for the Bored Tunnel Alternative, as discussed in Section 6.8.2. The objective of the investigation was to delineate the solvent distribution and determine the extent of soil that would qualify for a contained-out designation. Based on investigations performed by others, high concentrations of solvents were deemed unlikely.

Special handling requirements are mandated if Ecology grants a contained-out designation. Ecology may require direct hauling to a landfill if a temporary staging area or transfer station is not able to segregate this material and satisfy the special handling requirements.

Once Ecology is satisfied, it would provide a contained-out letter, which would allow soil disposal at a RCRA Subtitle D landfill. The cost for disposal at a Subtitle D landfill is substantially less than the cost for disposal at a Subtitle C landfill (see Section 6.6.2).

Management and disposal options for contaminated soils include the following:

- **Reuse.** Soils containing contaminants at concentrations less than the MCTA Method A cleanup levels are not restricted in use and could be used similarly to uncontaminated soils (including as backfill). Ecology has recommendations for the reuse of soil containing contaminants, particularly petroleum-contaminated soil. Because the soil would not be the result of a cleanup action, Ecology would not recognize it as "contaminated" soil. Consequently, it is not regulated as such under the Solid Waste Handling Standards (WAC-173-350). Placement of fill would also need to comply with local regulations and permits. Soil removed from the south end of the project area would generally not be suitable as fill for the project because of the wood debris that is comingled with the soil.
- **Land reclamation facility.** Excavated soil may be disposed of at a land reclamation facility permitted to accept the material. These facilities accept Class II impacted soil that is lightly contaminated material. They also accept non-woody construction debris, with an organic content of less than 5 percent. Soil with a pH greater than 8.5 may be disposed of at a facility with proper stormwater controls. Permit requirements are facility specific and may be more stringent than the MTCA Method A cleanup levels, particularly for petroleum.
- **RCRA Subtitle D landfill**. Soils contaminated with petroleum hydrocarbons or other contaminants at concentrations that exceed the land reclamation facility criteria or the Method A cleanup levels could be disposed of at a RCRA Subtitle D landfill permitted to accept such contaminated soils. These facilities also accept soils with high levels of organic matter, including timbers, sawdust, and wood debris. Timbers must be segregated to improve handling efforts. Soils contaminated with only petroleum and petroleum-related VOCs could be transported to a thermal treatment unit.

Soil containing solvents from a dry-cleaning operation is regulated as dangerous waste, which must be disposed of at a RCRA Subtitle C landfill. However, soil with a solvent concentration less than the MTCA Method B soil cleanup level can be managed such that it would not be considered a dangerous waste. Ecology can issue a contained-out designation that allows the soil to be disposed of at a RCRA Subtitle D landfill. Ecology has strict requirements, and if these requirements are not met, the soil would be classified as a dangerous waste.

- **RCRA Subtitle C landfill.** Soil designated as dangerous waste that does not receive a contained-out designation would require (1) disposal at a RCRA Subtitle C landfill permitted to accept hazardous materials, (2) bioremediation of hazardous materials with subsequent disposal at RCRA Subtitle C landfill, or (3) incineration at licensed facility.

> Dangerous waste also includes soil classified based on its leaching characteristics. The most common contaminant in the project area is lead that leaches at concentrations greater than 5 mg/L, as measured by TCLP.

On-site treatment of contamination is not a viable option. The soil contains many contaminants such as petroleum, PAHs, and metals. Multiple treatment technologies would be required to treat the different types of contaminants. Although petroleum is frequently treated on site, PAHs and metals would not be effectively treated by either land-farming or on-site thermal desorption. The range of petroleum compounds that have been encountered in the south area is primarily in lubricating oil and heavy-oil range, which is more difficult to treat. Thermal desorption and land-farming are not efficient at treating this range of petroleum compounds; low concentrations would still likely be detectable. The high wood content also hinders the soil management and disposal approaches. In addition, large volumes of spoils are expected, and there may be insufficient space to treat the soil effectively.

Contaminated Groundwater

Alternative approaches may be available to minimize the volume of water produced during construction, as described Section 6.8.4. The applicability of these methods should be evaluated throughout construction; particularly in areas of known contamination.

For contaminated groundwater generated during construction, containerization and characterization would be required to determine the approach to treatment. All dewatering water that is discharged would conform with applicable federal, state, and local regulations.

Groundwater containing contaminants could be treated to meet the requirements for local discharge, depending on the contaminants and their concentrations. Local discharge after treatment could include (1) discharge to surface water, (2) discharge to a POTW, or (3) off-site disposal at a private TSD facility.

Discharge directly or indirectly to surface water would require conformance with the criteria defined in WAC 173-201A and a permit from Ecology. Discharge to the local sewer system or a TSD facility would require approval from the facility, and the groundwater would likely require treatment before being discharged to a POTW. Water discharged to the sewer system would meet the discharge requirements of the King County Wastewater Discharge Permit or Authorization.

Pumped groundwater contaminated with spent dry-cleaning solvents from a property where dry cleaning is known to have occurred is characterized as an F002 listed dangerous waste, regardless of the detectable concentrations. Such water is prohibited from being discharged to a surface water body, and free liquid cannot be disposed of in the ground according to the land disposal restrictions.

The water could be treated on site using a GAC filter, but as long as it contains detectable concentrations of dry-cleaning solvents, the water would need to be discharged to a POTW or transported off site to a TSD facility. Once the solvents are no longer detectable, as demonstrated by appropriate analytical methods, the water could be disposed of off site as wastewater. The spent GAC would require disposal as an F-listed dangerous waste. If the dry-cleaning solvent cannot be removed, the water would require disposal as a dangerous waste.

Mitigation Options for Contaminated Building Debris

Demolition and disposal of dangerous waste requires special handling. If ACM is identified by a proper hazardous materials survey, mitigation would consist of removing the materials in compliance with the requirements of the Washington Industrial Safety and Health Act before building demolition and disposing of them in an approved facility. To minimize the volume of LBP debris requiring disposal as dangerous waste (waste containing lead that exceeds the disposal criterion) it should not be comingled with other inert building debris. A comprehensive building survey and sampling program before demolition would help limit the amount of material that would need to be removed and placed in the RCRA Subtitle D landfill or RCRA Subtitle C landfill (for dangerous waste), thereby minimizing costs.

6.9 Preliminary Cleanup Cost Estimate

Handling and disposal of contaminated soil and groundwater could pose a significant adverse impact on the project. Excavated soil that is contaminated will require special handling or will have restrictions on its disposal. Similarly, groundwater in the north and south areas may be contaminated. Dewatering in these areas would require additional evaluation, and the collected water would possibly require treatment before it could be discharged. Construction effects from contaminated media could be mitigated by developing a construction budget that includes the costs for managing and disposing of contaminated spoils and water. Early identification of contaminated soil and groundwater, and characterization of waste, may minimize the volume of contaminated spoils. Construction methods could be modified to address contaminated media, and contaminated spoils could be segregated for appropriate disposal.

Estimated costs to identify, plan, and implement management of contaminated media are discussed in the following subsections. These costs are associated with construction of the project, including elements such as relocation of utilities that may be implemented by other agencies. The costs are based on similar type projects in northwest Washington. Disposal companies and King County Metro provided a range of costs that depend on the contaminants that are present in the media and the volume of material.

6.9.1 Analytical Testing Costs

The costs for testing soil and/or groundwater samples for potential contaminants are indicated in Exhibit 6-8. Typical turnaround time for results from local laboratories is 2 weeks. For same-day turnaround (if feasible), the costs are usually double the costs for the standard 2-week turn-around. A surcharge of between 100 and 75 percent of the standard charge is applied for a 1-day turnaround. Costs for soil and groundwater testing are similar except for total metals analysis. Samples may be analyzed for one or any combination of the analytical tests.

Exhibit 6-8. Analytical Testing Costs

	Standard Cost per Sample	Cost for One-Day Turn-Around (With 100% Surcharge)
Diesel- and heavy-oil-range hydrocarbons	$75	$150
Gasoline-range hydrocarbons	$70	$140
VOCs	$170	$340
PAHs	$190	$380
Eight RCRA metals (soil)	$105	$210
Eight RCRA metals (water)	$130	$260
TCLP for metals	$170	$340
PCBs	$90	$180

Notes: These costs are based on analytical costs charged by Seattle-based laboratories that have analyzed samples for this project: CCI Analytical Laboratories Inc., Everett, Washington; OnSite Environmental Inc., Redmond, Washington; and Fremont Analytical, Seattle, Washington.

PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
RCRA = Resource Conservation and Recovery Act
TCLP = Toxicity Characteristic Leaching Procedure
VOC = volatile organic compound

6.9.2 Underground Storage Tank Removal/Closure Costs

The following costs are for tank removal and disposal only and do not include the cost of overexcavation or trucking of soil to the selected disposal/treatment facility, if required:

Household heating oil tank	$3,000 per tank
Service station tank	$5,000 to $10,000 per tank
Product/sludge disposal	$2 to $4 per gallon
UST site assessment (no known release)	$3,000 to $7,500 per site

A site assessment is not required for unregistered household heating oil tanks where no release has occurred.

6.9.3 Soil Disposal and Treatment Costs

The following costs are for soil disposal only and do not include the cost of excavation or trucking to the selected disposal/treatment facility:

Petroleum-contaminated soils:

Thermal treatment	$30 to $35 per ton
Landfill disposal	$20 to $30 per ton

Soils contaminated with halogenated solvents, EPA priority pollutants, and/or corrosive waste:

Landfill disposal of non-dangerous waste	$30 per ton
Landfill disposal of dangerous waste	$180 per ton
Incineration of dangerous waste	$600 per ton

On-site treatment is not practical for contaminated soil removed at the south end of the project area. Soil would require treatment for petroleum hydrocarbons, mostly oil range, which is difficult to remove from soil with high levels of organics, and in areas with heavy metals.

6.9.4 Groundwater Treatment and/or Disposal Costs

The following costs for groundwater treatment and/or disposal options include permitting for local discharge and/or off-site treatment and disposal:

Permitting for local discharge:	$2,500 to $10,000, depending on type and level of contaminants present
Off-site treatment and disposal:	$0.25 to $2 per gallon, depending on type and level of contaminants present
On-site treatment and disposal:	$0.005 to $0.25 per gallon, depending on type and level of contaminants present

6.9.5 Contaminated Building Debris Costs

The cost estimates provided in this section are unit cost estimates, because the volume of potential ACM and/or contaminated soil that could be encountered during project construction is unknown at this time. The cost estimate for a predemolition building survey is $1,500 to $6,000 per residential structure, depending on the size of structure and the number of structures involved.

The following is a sample list of ACM that could be found in the various buildings and their associated removal/disposal costs. Estimated costs for preparing abatement specifications and for providing abatement oversight are also included.

Ceiling tiles	$2 to $3 per square foot
Textured ceiling (popcorn)	$5 to $7 per square foot

Fire doors	$50 to $75 per door
Sheet flooring	$3 to $5 per square foot
Floor tiles (9- or 12-inch)	$1 to $2 per square foot
Mastic (floor tile or sheet flooring)	$2 to $4 per square foot
Wallboard, tape, and mud	$2 to $4 per square foot
Roofing (built-up)	$1 to $2 per square foot
Roof patching	$1 to $2 per square foot
PSCAA permit	$25 to $2,000, depending on the project size and number of structures involved
Preparation of abatement specifications	$5,000 to $15,000
Abatement oversight	$500 or 10 percent of total abatement costs, whichever is greater

Chapter 7 TOLLING

Tolling could be implemented only once the replacement facility is operational; therefore, it should have no effect on the properties with the potential to contain hazardous materials that could be disturbed in the study area. Consequently, there would be no effect on the removal or disposal of any contaminated soils or other hazardous materials that may be buried beneath areas where construction and excavation would be needed.

Further detail on tolling, the variables that were examined, and the operational analysis is provided in Appendix C, Transportation Discipline Report.

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ATTACHMENT A

EDR Study Area Report

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ATTACHMENT B

Sites Excluded Based on Screening Criteria

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ATTACHMENT C

Potential Underground Storage Tanks

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ATTACHMENT D

Historical Land Uses of Sites

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ATTACHMENT E

Windshield Survey

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ATTACHMENT F

Analytical Data

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ATTACHMENT G

Summary Tables of Validated Sites

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ATTACHMENT H

Summary Tables of Property Acquisitions

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ATTACHMENT I

Applicable Federal and State Laws and Regulations

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ATTACHMENT J

Standard Impacts and Mitigation Measures

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