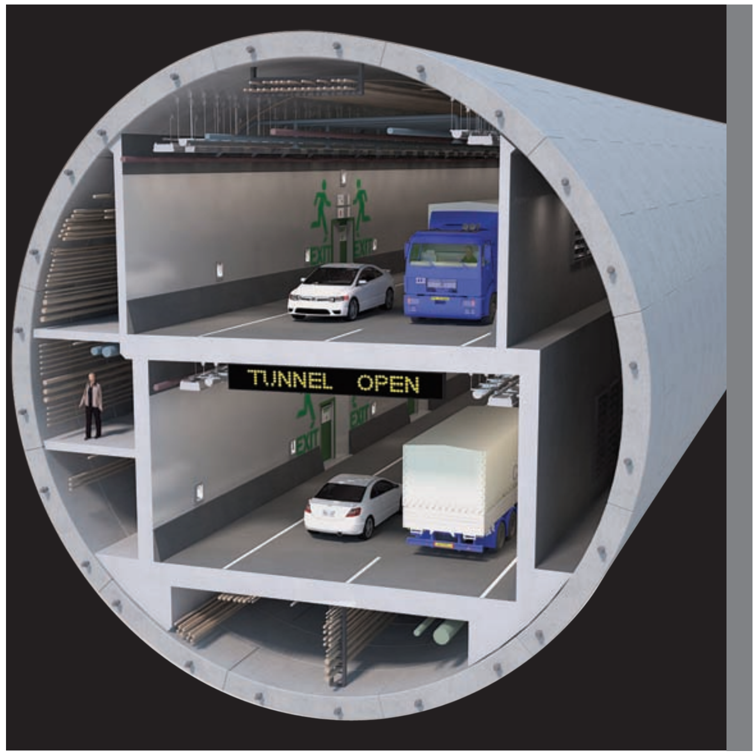
ALASKAN WAY VIADUCT REPLACEMENT PROJECT

2010 Supplemental Draft Environmental Impact Statement

APPENDIX O Surface Water Discipline Report



Submitted by:
PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Prepared by:
PARAMETRIX

U.S. Department of Transportation
Federal Highway Administration

Washington State Department of Transportation

City of Seattle

OCTOBER 2010

This Page Intentionally Left Blank

Alaskan Way Viaduct Replacement Project

Supplemental Draft EIS
Surface Water 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:

Parsons Brinckerhoff
999 Third Avenue, Suite 3200
Seattle, WA 98104

In association with:
Coughlin Porter Lundeen, Inc.
EnviroIssues, Inc.
GHD, Inc.
HDR Engineering, Inc.
Jacobs Engineering Group Inc.
Magnusson Klemencic Associates, Inc.
Mimi Sheridan, AICP
Parametrix, Inc.
Power Engineers, Inc.
Shannon & Wilson, Inc.
William P. Ott Construction Consultants

This Page Intentionally Left Blank

TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

BMP	best management practice
City	City of Seattle
County	King County
CSL	cleanup screening level (Washington State)
EBI	Elliott Bay Interceptor
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
GSI	green stormwater infrastructure
I-5	Interstate 5
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PGIS	pollutant-generating impervious surface(s)
Program	Alaskan Way Viaduct and Seawall Replacement Program
project	Alaskan Way Viaduct Replacement Project
SPU	Seattle Public Utilities
SQS	sediment quality standard(s)
SR	State Route
TBM	tunnel boring machine
TIA	total impervious area
TMDL	total maximum daily load
TSS	total suspended solids
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WWTP	wastewater treatment plant

Chapter 1 INTRODUCTION AND SUMMARY

1.1 Introduction

This discipline report evaluates the Bored Tunnel Alternative, the new alternative under consideration for replacing the Alaskan Way Viaduct. This report and the Alaskan Way Viaduct Replacement Project Supplemental Draft Environmental Impact Statement (EIS) that it supports are intended to provide new information and updated analyses to those presented in the March 2004 Alaskan Way Viaduct and Seawall Replacement Project Draft EIS and the July 2006 Alaskan Way Viaduct and Seawall Replacement Project Supplemental Draft EIS. The discipline reports present the detailed technical analyses of existing conditions and predicted effects of the Bored Tunnel Alternative. The results of these analyses are presented in the main volume of the Supplemental Draft EIS.

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. As part of the NEPA process, FHWA is also responsible for selecting the preferred alternative. FHWA will base their decision on the information evaluated during the environmental review process, including information contained within the Supplemental Draft EIS and the subsequent Final EIS. FHWA can then issue their 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 the city of Seattle. The March 2007 ballot included an elevated alternative and a surface-tunnel hybrid alternative. The citizens voted down both alternatives.

Following this election, the lead agencies committed to a collaborative process to find a solution to replace the viaduct along Seattle's central waterfront. This Partnership Process is described in Appendix S, the Project History Report. 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.

The environmental review process for the Alaskan Way Viaduct Replacement Project (the project) builds on the five Build Alternatives evaluated in the 2004

Draft EIS and the two Build Alternatives evaluated in the 2006 Supplemental Draft EIS. It also incorporates the work done during the Partnership Process. The bored tunnel was not studied as part of the previous environmental review process, and so it becomes the eighth alternative to be evaluated in detail.

The Bored Tunnel Alternative analyzed in this discipline report and in the Supplemental Draft EIS has been evaluated both quantitatively and qualitatively. The Bored Tunnel Alternative includes replacing State Route (SR) 99 with a bored tunnel and associated improvements, such as relocating utilities located on or under the viaduct, removing the viaduct, decommissioning the Battery Street Tunnel, and making improvements to the surface streets in the tunnel's south and north portal areas.

Improvements at the south portal area include full northbound and southbound access to and from SR 99 between S. Royal Brougham Way and S. King Street. Alaskan Way S. would be reconfigured with three lanes in each direction. Two options are being considered for new cross streets that would intersect with Alaskan Way S.:

- New Dearborn Intersection – Alaskan Way S. would have one new intersection and cross street at S. Dearborn Street.
- New Dearborn and Charles Intersections – Alaskan Way S. would have two new intersections and cross streets at S. Charles Street and S. Dearborn Street.

Improvements at the north portal area would include restoring Aurora Avenue and providing full northbound and southbound access to and from SR 99 near Harrison and Republican Streets. Aurora Avenue would be restored to grade level between Denny Way and John Street; and John, Thomas, and Harrison Streets would be connected as cross streets. This rebuilt section of Aurora Avenue would connect to the new SR 99 alignment via the ramps at Harrison Street. Mercer Street would be widened for two-way operation from Fifth Avenue N. to Dexter Avenue N. Broad Street would be filled and closed between Ninth Avenue N. and Taylor Avenue N. Two options are being considered for Sixth Avenue N. and the southbound on-ramp:

- The Curved Sixth Avenue option proposes to build a new roadway that would extend Sixth Avenue N. in a curved formation between Harrison and Mercer Streets. The new roadway would have a signalized intersection at Republican Street.
- The Straight Sixth Avenue option proposes to build a new roadway that would extend Sixth Avenue N. from Harrison Street to Mercer Street in a typical grid formation. The new roadway would have signalized intersections at Republican and Mercer Streets.

For these project elements, the analyses of effects and benefits have been quantified with supporting studies, and the resulting data are found in the discipline reports (Appendices A through R). These analyses focus on assessing the Bored Tunnel Alternative's potential effects for both construction and operation, and consider appropriate mitigation measures that could be employed. The Viaduct Closed (No Build Alternative) is also analyzed.

The Alaskan Way Viaduct Replacement Project is one of several independent projects that improve safety and mobility along SR 99 and the Seattle waterfront from the South of Downtown (SODO) area to Seattle Center. Collectively, these individual projects are often referred to as the Alaskan Way Viaduct and Seawall Replacement Program (the Program). This Supplemental Draft EIS evaluates the cumulative effects of all projects in the Program; however, direct and indirect environmental effects of these independent projects will be considered separately in independent environmental documents. This collection of independent projects is categorized into four groups: roadway elements, non-roadway elements, projects under construction, and completed projects.

Roadway Elements

- Alaskan Way Surface Street Improvements
- Elliott/Western Connector
- Mercer West Project (Mercer Street improvements from Fifth Avenue N. to Elliott Avenue)

Non-Roadway Elements

- First Avenue Streetcar Evaluation
- Transit Enhancements
- Elliott Bay Seawall Project
- Alaskan Way Promenade/Public Space

Projects Under Construction

- S. Holgate Street to S. King Street Viaduct Replacement
- Transportation Improvements to Minimize Traffic Effects During Construction

Completed Projects

- SR 99 Yesler Way Vicinity Foundation Stabilization (Column Safety Repairs)
- S. Massachusetts Street to Railroad Way S. Electrical Line Relocation Project (Electrical Line Relocation Along the Viaduct's South End)

1.2 Summary

This section provides an overview of the surface water study conducted for the project. It summarizes the potential water quality effects and benefits of the proposed Bored Tunnel Alternative and mitigation measures that can be implemented to minimize potential water quality effects.

Chapter 2 describes the proposed surface water management approaches for each alternative and the methods used to conduct the surface water analysis detailed in this report.

Chapter 3 describes the studies and coordination that contributed to this report.

Chapter 4 describes the current surface water conditions within the affected environment, including the sub-basins that receive runoff from the project area; the existing systems for managing surface water, stormwater, and sewer flows within the project area; the receiving waters of central Puget Sound, Elliott Bay, and Lake Union, and the condition of nearshore sediments adjacent to project outfalls.

Chapter 5 describes the operational effects of the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative on surface water conditions in the project area, as compared to the current conditions detailed in Chapter 4, along with proposed mitigation for the expected adverse effects of the project.

Chapter 6 describes the effects of construction of the Bored Tunnel Alternative on surface water conditions and management systems in the project area, along with proposed mitigation measures for the expected short-term adverse effects.

Chapter 7 describes the cumulative effects of the Bored Tunnel Alternative on surface water conditions and management systems, especially in relation to other Program elements.

Chapter 8 lists the references used to prepare this report.

Attachment A describes the analysis conducted to evaluate changes in pollutant load carried by runoff from the study area established for the analysis of project-related effects on surface water.

Attachment B describes the method used to analyze the cumulative effects for the Bored Tunnel Alternative and discusses potential cumulative effects from both the Program and independent projects.

The following sections summarize the key findings of this report.

1.2.1 Affected Environment

The surface water study area covers approximately 53 acres as discussed in Chapter 2 (see Exhibit 2-1). This area drain to 12 different sub-basins, as discussed in Chapter 4. (See also Exhibits 4-1 through 4-3). The study area has been developed for more than 100 years and consists predominantly of impervious surfaces. Most of the stormwater runoff from the study area currently discharges to the combined sewer system, which discharges to Puget Sound through the West Point wastewater treatment plant (WWTP). Sometimes, during heavy rains, stormwater in the combined sewer system discharges flows directly to Elliott Bay or Lake Union without treatment as a combined sewer overflow. Runoff from smaller portions of the study area discharges directly to Elliott Bay and Lake Union. The pipes within all of the drainage systems discussed are owned and maintained by private entities, King County (County), or Seattle Public Utilities (SPU). Chapter 4 provides a detailed description of the conveyance system within the study area and the associated receiving waters.

1.2.2 Operational Effects, Mitigation, and Benefits

In general, runoff from streets and highways, particularly in urban environments, contains pollutants that can affect the water quality of the receiving water body. These pollutants typically include copper, zinc, and petroleum hydrocarbons. Pollutant loads contained in stormwater runoff vary depending on the amount and type of pollutant-generating impervious surface (PGIS), traffic volumes and average speed, duration and intensity of a storm event, time of year, antecedent weather conditions, and several other factors. Pollutant loads reaching the receiving water can be reduced through the use of water quality best management practices (BMPs).

Annual pollutant loads in stormwater under existing conditions, the Viaduct Closed (No Build Alternative), and the Bored Tunnel Alternative were analyzed and compared. The results of this analysis, which are discussed in Section 5.2 and detailed in Attachment A, indicate that pollutant loads would be reduced as compared to existing conditions on average by approximately 19 percent under the Viaduct Closed (No Build Alternative) and 28 percent under the Bored Tunnel Alternative. The major differences in pollutant load between existing conditions and the two alternatives are the result of decreased amounts of PGIS.

1.2.3 Construction Effects and Mitigation

The construction-related effects of the Bored Tunnel Alternative, as detailed in Section 6.1, would be temporary. These effects would generally result from staging, material transport, earthwork, soil stockpiling, storm drainage and/or combined sewer utility work, and dewatering. Construction-related pollutants could increase turbidity, decrease the available oxygen in the water, and increase pH. As detailed in Section 6.2, construction-related effects on surface water would be minimized or prevented by the development and implementation of certain management plans and the selection and implementation of appropriate construction BMPs.

This Page Intentionally Left Blank

Chapter 2 METHODOLOGY

This chapter outlines the procedures used to (1) define the study area, (2) evaluate potential environmental effects of the Bored Tunnel Alternative and the Viaduct Closed (No Build Alternative), (3) analyze potential effects from construction-related runoff, and (4) identify possible mitigation measures for avoiding or minimizing adverse environmental effects or enhancing environmental quality during construction and operation.

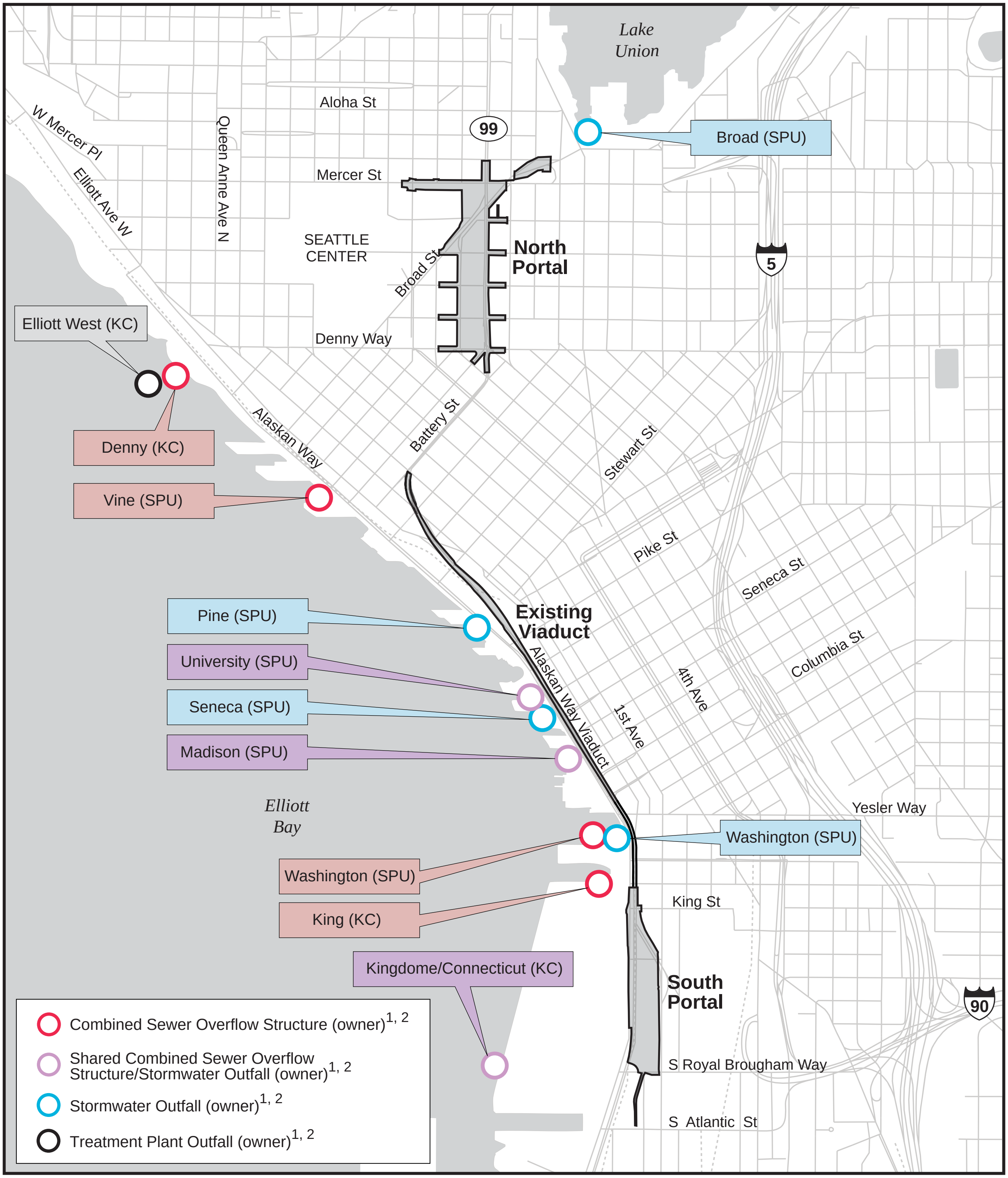
2.1 Study Area

The study area includes combined sewer service areas and stormwater drainage sub-basins, outfall locations, receiving waters, and nearshore sediment in the vicinity of project-related outfalls (Exhibits 2-1 and 2-2). The study area was determined by reviewing existing stormwater utility drawings, technical reports for the vicinity of the project area, drainage flow paths from the project area, and locations of outfalls that discharge to surface receiving waters.

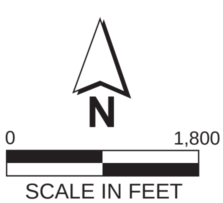
The following project elements would occur within the study area:

- Removal of the existing viaduct structure.
- Replacement of SR 99 through the existing viaduct corridor with a bored tunnel.
- Relocation of utilities located on or under the existing viaduct.
- Modifications to the surface streets at the south portal of the tunnel.
- Modifications to the surface streets at the north portal of the tunnel.
- Decommissioning of the Battery Street Tunnel.

The study area also includes the maximum extent of both the New Dearborn Intersection option and New Dearborn and Charles Intersections option in the south portal area, as well as the maximum extent of both the Curved Sixth Avenue option and the Straight Sixth Avenue option in the north portal area.



554-1585-030/CC(07) 7/6/10

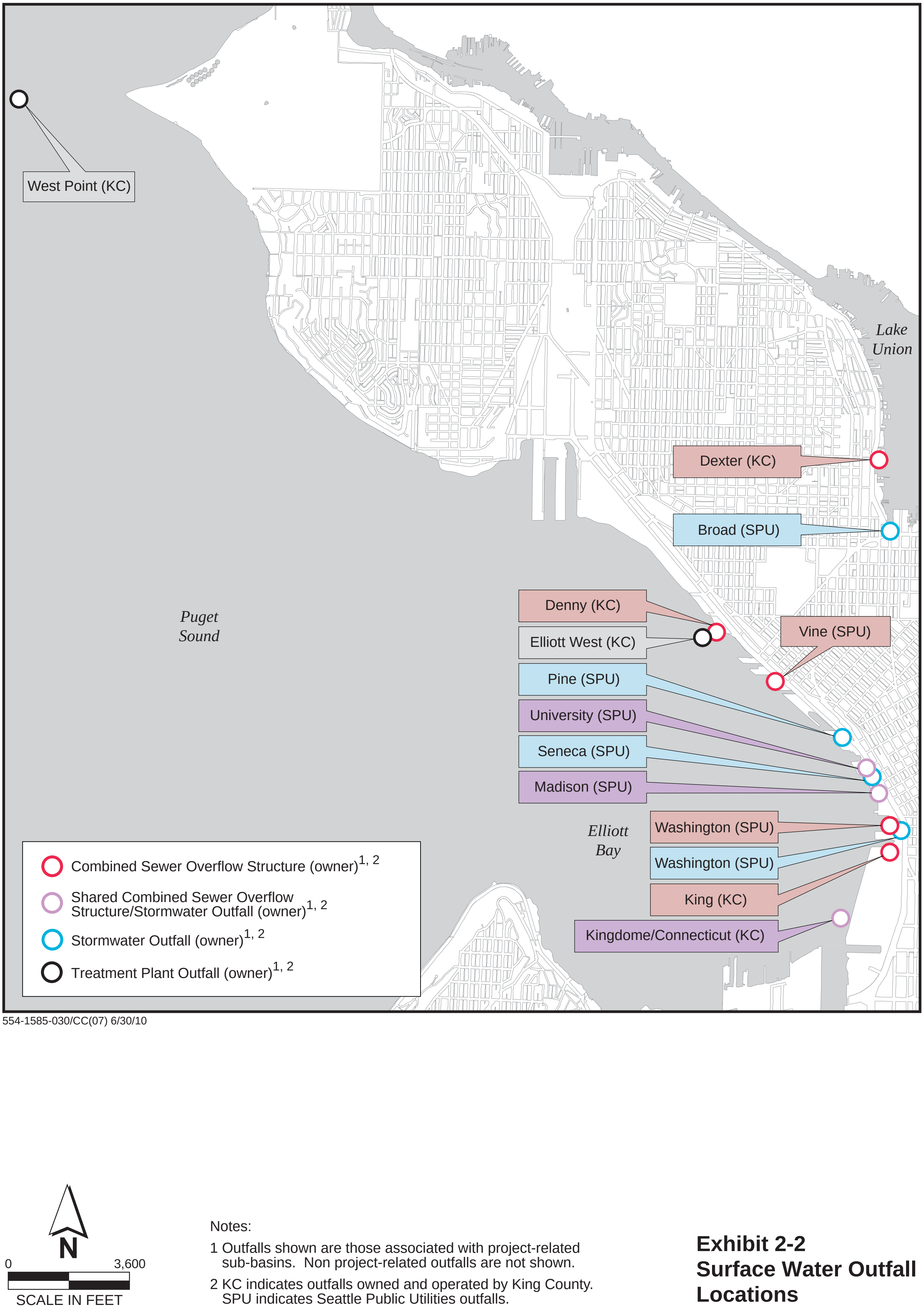


Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 2-1
Surface Water Study Area



Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 2-2
Surface Water Outfall Locations

2.2 Stormwater Management Approach

2.2.1 Viaduct Closed (No Build Alternative)

Under the Viaduct Closed (No Build Alternative), this study assumes that if the viaduct is removed, the existing drainage system for the viaduct structure would be removed and the remaining drainage systems in affected areas would be protected or replaced in kind. Stormwater flow control and water quality facilities would be those that exist under current conditions.

2.2.2 Bored Tunnel Alternative

In general, the proposed stormwater management approach for the Bored Tunnel Alternative would maintain the existing drainage patterns in on-site areas, with some shifts as described below. Existing drainage patterns would be maintained for all off-site stormwater (stormwater generated outside the study area) to convey it in pipes that pass through the study area.

For stormwater from the project area that discharges to the combined sewer system, water quality treatment at the West Point WWTP would continue to be provided, similar to existing conditions. Also, in accordance with the requirements of the Seattle Stormwater Code, peak flow control would be added for runoff discharging to the combined sewer system through the use of on-site or off-site detention BMPs. However, as described below, an exception from flow control standards has been granted for the south portal area.

Stormwater runoff from the proposed PGIS that is not routed to the combined sewer system would be treated on site with water quality BMPs selected from the Seattle *Stormwater Manual* (Seattle 2009a) and/or the Washington State Department of Transportation (WSDOT) *Highway Runoff Manual* (WSDOT 2008b).

Under the Bored Tunnel Alternative, existing storm drainage utility lines would be removed and/or abandoned in place, and new storm drainage utility lines would be installed for most of the south and north portal areas. Remaining drainage systems in areas affected by the removal of the existing viaduct structure would be protected or replaced in kind. Details regarding the analysis of the storm drainage and combined sewer utility systems for the proposed action are presented in Appendix K, Public Services and Utilities Discipline Report.

South Portal Area

In the south portal area, existing drainage patterns would generally be maintained, with minor shifts in surface area between the North Royal Brougham and King combined sewer sub-basins.

Flow control would not be provided in the south portal area, because modeling has shown that detention would not reduce the potential frequency and/or volume of overflows from the combined sewer system. Therefore, an exception from the peak flow control requirements has been granted by the City of Seattle (City) for the south portal area (Seattle 2009b).

Bored Tunnel

Some stormwater is expected to enter the tunnel at each portal area. This water would be pumped to each respective portal and discharged to the combined sewer system. In addition, drainage flows are expected to be generated within the bored tunnel from several non-stormwater sources, including testing and operation of the emergency fire suppression system, tunnel washing, and groundwater seepage. This water would be pumped to the south portal, where it would be discharged to the combined sewer system.

North Portal Area

In the north portal area, two separate stormwater management scenarios are being considered: the Separated Storm and Combined Sewer stormwater management scenario and the Combined Sewer stormwater management scenario.

- The Separated Storm and Combined Sewer stormwater management scenario would discharge surface water from the north portal area into both the Broad separated storm drainage sub-basin and the Dexter combined sewer sub-basin. After the Broad Street underpass is abandoned and filled to grade, the area that currently discharges to the Broad separated storm drainage sub-basin would discharge to the Dexter combined sewer sub-basin. To offset the additional discharge to the Dexter combined sewer sub-basin, runoff from Sixth Avenue N. that is currently collected by the Dexter sub-basin would be redirected to the Broad sub-basin. The net shift would result in the addition of 1.1 acres to the Broad sub-basin.
- The Combined Sewer stormwater management scenario would direct surface water runoff from the entire north portal area into the Dexter combined sewer sub-basin. Under this scenario, approximately 4.9 acres would be shifted from the Broad sub-basin to the Dexter sub-basin, and an additional pump station would potentially be required. The City of Seattle would be required to pay King County a fee for the increase in contributing area to the combined sewer system (CH2M Hill 2010).

2.3 Applicable Regulations and Guidelines

Water quality and sediment standards for fresh and marine waters in Washington State are established in Washington Administrative Code, Chapters 173-201A and

173-204, respectively (WAC 173-201A and 173-204). In addition, several agencies have laws, statutes, local ordinances, and guidelines that address surface water management. Exhibit 2-3 summarizes the stormwater management requirements and guidelines reviewed as part of the evaluation of surface water in the study area.

Exhibit 2-3. Summary of Requirements and Guidance Documents

Agency	Requirements/Guidance Documents
Washington State Department of Ecology	Total maximum daily loads and 303(d) lists (Ecology 2009) *Stormwater Management Manual for Western Washington* (Ecology 2005)
Washington State Department of Transportation	2010 *Environmental Procedures Manual* (WSDOT 2010a) *Highway Runoff Manual* (WSDOT 2008b)[1]
King County	*King County Surface Water Design Manual* (King County 2009a)[1]
City of Seattle	Seattle Stormwater Code (Seattle Municipal Code, Chapters 22.800–22.808) and supporting *Stormwater Manual* (Seattle 2009a)[1]

1. The Department of Ecology has determined that these manuals meet minimum design requirements and BMPs equivalent to those in the Department of Ecology's *Stormwater Management Manual for Western Washington* (Ecology 2005).

2.4 Data Sources

Water quality reports, sediment quality data, surface water management plans, and sub-basin and utility maps collected for previous phases of the Program were reviewed, in addition to newly acquired information, as applicable. Information collected for this review included maps and qualitative descriptions of utilities and outfalls from WSDOT, the City, and the County. Also reviewed was information on the frequency and volume of discharges to surface receiving waters from the combined sewer system. For the evaluation of temporary construction-related effects, groundwater information collected for Appendix P, Earth Discipline Report, was reviewed in terms of the quality and quantity of dewatering water.

The following agencies provided information to assist in the preparation of this report.

City of Seattle

- Detailed maps of the existing storm drainage and combined sewer system, including sub-basin boundaries.
- Combined sewer overflow reduction plan documents.
- Shoreline Master Program documents relating to nearshore sediment.

Washington State Department of Ecology

- Section 303(d) List of Threatened and Impaired Water Bodies.
- Nearshore sediment quality data, studies, and management plans.

King County

- Detailed maps of the existing combined sewer system, including sub-basin boundaries.
- Frequency and volumes of combined sewer overflow events.
- Combined sewer overflow control plan documentation.
- Nearshore sediment quality information.

A description of the City's and County's existing storm drain, low-flow diversion, and combined sewer systems was developed from the following sources:

- Drainage maps of the existing storm drain and combined sewer networks, including stormwater drainage sub-basins, combined sewer service areas, existing BMPs, and outfall locations and sizes.
- Water quality data collected as part of the National Pollutant Discharge Elimination System (NPDES) municipal stormwater program or data from other previous studies.
- Frequency and volumes of combined sewer overflow events, based on previous studies.

2.5 Analysis of Existing Conditions

The term *existing conditions* as it pertains to the affected environment refers to the period just before construction of the project, which is expected to begin in 2011. Existing conditions in the study area that could potentially be affected by the Bored Tunnel Alternative were identified and are discussed in Chapter 4. The surface water analysis focused on the natural environment (Puget Sound, Elliott Bay, and Lake Union) and the existing stormwater and combined sewer system.

Existing conditions in terms of the quality of surface water and nearshore sediment in Puget Sound, Elliott Bay, and Lake Union were characterized using studies conducted by various entities, including the City, the County, and the Washington state Department of Ecology (Ecology). Floodplain boundaries were not addressed in the existing conditions analysis because there are no floodplains associated with Elliott Bay or Lake Union (FEMA 1995a, 1995b). WSDOT has also confirmed that there are no streams, wetlands, or drinking wells in the study area, so these elements have not been evaluated. The condition of the existing shoreline is discussed in Appendix N, Wildlife, Fish, and Vegetation Discipline Report.

2.6 Analysis of Environmental Effects

2.6.1 Operational Effect Analysis

Potential operational effects were analyzed under existing conditions, the Viaduct Closed (No Build Alternative), and the Bored Tunnel Alternative. The timeframe for operational effects is from the year of opening (2015) to the project design year (2030). Potential operational effects on hydrology, surface water quality, and nearshore sediments were evaluated.

Potential effects on hydrology were evaluated by comparing land use changes under each alternative to existing conditions. In addition, potential effects on the volume and frequency of flows under both alternatives were evaluated assuming that the project is committed to meeting City flow control requirements for discharges to storm drain and combined sewer systems.

Potential operational effects of the project alternatives on water quality were evaluated by generating a quantitative pollutant load analysis using the WSDOT Method 1, based on the guidance in the 2010 *Environmental Procedures Manual* (WSDOT 2010a) and outlined in *Quantitative Procedures for Surface Water Impact Assessments* (WSDOT 2009). The design options and scenarios for the Bored Tunnel Alternative that were included in the pollutant loading analysis are the following:

- The south portal, New Dearborn Intersection option
- The south portal, New Dearborn and Charles Intersections option
- The central project area, in the vicinity of the existing viaduct
- The north portal, Curved Sixth Avenue option, separated storm and combined sewer stormwater management scenario
- The north portal, Curved Sixth Avenue option, combined sewer stormwater management scenario
- The north portal, Straight Sixth Avenue option, separated storm and combined sewer stormwater management scenario
- The north portal, Straight Sixth Avenue option, combined sewer stormwater management scenario

Potential effects on nearshore sediments due to the change in pollutant loading were qualitatively evaluated for Elliott Bay, Lake Union, and Puget Sound (for areas draining stormwater to the combined sewer outfall at the West Point WWTP), assuming that changes in annual pollutant load affect changes in sediment quality. The operational effects, mitigation, and benefits of the project are discussed in Chapter 5.

2.6.2 Construction Effects Analysis

The timeframe for construction-related (temporary) effects is the approximately 66-month construction period for the Bored Tunnel Alternative (2011 through 2017). The following methods were used to qualitatively evaluate the potential for temporary construction effects from the Bored Tunnel Alternative:

- Identification of all locations where (1) the work area may be exposed to precipitation and/or runon, (2) work would occur in or over the water (if applicable), and (3) work would require dewatering to identify existing pollutants that may be of concern to surface water resources.
- Use of existing third-party data to identify possible pollutants of concern for surface water.
- Use of groundwater data from Appendix P, Earth Discipline Report, to identify pollutants of concern that may be encountered during dewatering activities.
- Use of groundwater dewatering volume estimates from the design team and Appendix P, Earth Discipline Report, to identify potential erosion and/or sediment transport during disposal of dewatering water.
- Evaluation of potential unavoidable effects, if applicable, despite the use of proposed construction BMPs.

The findings of the construction effects analysis and a discussion of potential mitigation are included in Chapter 6.

2.6.3 Cumulative Effects Analysis

Cumulative effects are effects on the environmental that result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. The potential cumulative effects of the Bored Tunnel Alternative were qualitatively analyzed in combination with other Program elements and other projects in the study area. The potential for cumulative effects from each project was evaluated based on the *Guidance on Preparing Cumulative Impact Analyses* (WSDOT 2008a). Also, for each project included in the analysis, the following factors were considered:

- Potential effects on surface water in the vicinity of the study area.
- Potential ground-disturbing activities that could trigger stormwater retrofitting.
- Potential for scheduling below-grade work, if applicable, to occur simultaneously with the Bored Tunnel Alternative to reduce excavation activities.

- Potential for increasing flows to combined sewer system because of increased sewage supply (such as with residential developments).
- Potential for reducing combined sewer overflow events.

Projects that were included in the qualitative analysis are described below.

Program Elements

Other Roadway Elements

The other roadway elements of the Program are not part of the Bored Tunnel Alternative. These elements were analyzed qualitatively at a level of detail analogous to that used in screening-level environmental analysis. The following projects were included in the analysis:

- Alaskan Way Surface Street Improvements (on the location of the former viaduct) from S. King Street to Pike Street
- Elliott/Western Connector from Pike Street to Battery Street
- Mercer West Project (Mercer Street improvements from Fifth Avenue N. to Elliott Avenue)

Non-Roadway Program Elements

The following non-roadway elements of the Program were also qualitatively evaluated:

- Elliott Bay Seawall Project
- Alaskan Way Promenade/Public Space
- First Avenue Streetcar Evaluation
- Transit Enhancements

Other Projects

The cumulative effects analysis for surface water also considered other planned projects and developments in the vicinity of the study area. The following projects were included in the cumulative effects analysis:

- Sound Transit projects
- S. Spokane Street Viaduct Widening
- SR 519 Intermodal Access Project, Phase 2
- SR 520 Bridge Replacement and HOV Program
- I-5 Improvements
- South Lake Union Redevelopment
- Mercer East Project from I-5 to Dexter Avenue N.

Combined sewer overflow events were qualitatively evaluated as part of the analysis of cumulative operational effects. Potential benefits to water and sediment quality in Puget Sound, Elliott Bay, and Lake Union were qualitatively evaluated using documentation and analysis prepared for the joint projects.

Findings of the cumulative effects analysis associated with the Program are discussed in Chapter 7. A more detailed analysis of cumulative effects is provided in Attachment B.

2.7 Determination of Mitigation Measures

Mitigation measures are steps that may be taken to potentially lessen adverse effects (both significant and nonsignificant) identified for a proposed action. WSDOT also classifies some actions as conservation measures, which are required activities or standard practices that are routinely used on WSDOT projects to avoid or minimize impacts on water quality and quantity. Based on the 2010 *Environmental Procedures Manual* (WSDOT 2010a) and the *Surface Water Discipline Report Technical Guidance* (WSDOT 2010b), the following sequence of actions was considered during the evaluation of potential mitigation/conservation measures for the Bored Tunnel Alternative:

1. Avoid the impact altogether by not taking a certain action or parts of an action (conservation).
2. Minimize impacts by limiting the degree or magnitude of the action and its implementation (conservation).
3. Rectify the impact by repairing, rehabilitating, or restoring the affected environment (mitigation).
4. Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action (mitigation).
5. Compensate for the impact by replacing or providing substitute resources or environments (mitigation).

A qualitative evaluation of mitigation measures was conducted using best professional judgment and experience to identify relevant, reasonable strategies that might address project-specific effects. Section 5.5 discusses the results of the evaluation of mitigation measures.

This Page Intentionally Left Blank

Chapter 3 STUDIES AND COORDINATION

This report was prepared using information obtained from various sources, including the following:

- City of Seattle
- WSDOT
- King County
- Ecology
- Project design team

3.1 Studies

The following studies served as the foundation and provided background information for the preparation of this report:

- *Bored Tunnel Corridor Final Conceptual Hydraulic Report* (CH2M Hill 2010)
- *SR 99 Bored Tunnel Alternative – Summary Level Stormwater Report* (Rosewater GHD 2009)
- *Combined Sewer System Analysis Study* (HDR 2007)
- *SR 99 Bored Tunnel Alternative – Final Staging, Sequencing, Constructibility, and Construction Impacts Study* (Parsons Brinckerhoff 2009a)
- *2008 Washington State's Water Quality Assessment [303(d)]* (Ecology 2009)
- The Environmental Information Management Database (Ecology 2006)
- *Combined Sewer Overflow Control Program 2007–2008 Annual Report* (King County 2008)
- *Combined Sewer Overflow Control Program 2008 Annual Report* (King County 2009b)

3.2 Coordination

Several meetings were held with WSDOT, the City, and design team members throughout the preparation of this report to establish project design conditions and assumptions to use in the evaluation of project-related effects on water resources in the study area. The City also provided geographic information system (GIS) data necessary to document and map the existing combined sewer and stormwater drainage systems. Information about specific drainage sub-basin boundaries within the study area was provided by the design team.

This Page Intentionally Left Blank

Chapter 4 AFFECTED ENVIRONMENT

This chapter describes both the built and the natural environments that could potentially be affected by the construction and operation of the proposed Bored Tunnel Alternative. Specifically, it describes the existing drainage patterns, water quality, and nearshore sediment quality of the surface water and associated water bodies that receive runoff from the study area. It also identifies locations where the natural environment may be more susceptible to temporary or long-term effects.

4.1 Surface Water Study Area

The study area (Exhibit 2-1) covers approximately 53 acres, which have been developed for more than 100 years and consist of predominantly impervious surface. It encompasses portions of the drainage basins located within the project area and the associated surface water outfalls and receiving waters (Exhibit 2-2). The larger drainage basin outside the specific project area is not included in the study area.

The study area is part of the highly developed downtown urban corridor along the Elliott Bay waterfront. Development and associated activities have degraded the quality of surface water and nearshore sediments of receiving water bodies surrounding the study area, including Puget Sound, Elliott Bay, and Lake Union. Specific sources of surface water pollutants in the study area include discharges from industrial facilities, combined sewer overflows, spills, and urban storm drains, which include roadway runoff (Ecology 1995). Pollutants that have been found in receiving water sediments in the study area that are most likely to have been generated from urban roadway runoff include copper, zinc, and petroleum hydrocarbons. Other pollutants that have been found in the sediments include fecal coliform bacteria, mercury, lead, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

4.2 Existing Drainage System Overview

Historically, a conveyance system was built in Seattle to collect both sanitary sewage and stormwater in a single pipe and convey it to a discharge location. In the early 1960s, the Municipality of Metropolitan Seattle (Metro, now part of King County) was formed under the Comprehensive Sewer Plan, and work began to reduce the annual volume of untreated sanitary and combined sewage discharge to surface waters in King County. Metro completed a variety of projects (including treatment plants, interceptor pipes, regulators, and separation projects) to reduce combined sewer overflows. As part of this program, the City and Metro constructed several projects within the study area that have reduced the frequency and volume of combined sewer overflows (Metro 1988a). The goal of these projects and others outlined in the *1988 Combined Sewer Overflow Control Plan* was to reduce the total volume of combined sewer overflow discharge (Metro 1988a). Both the City and the County have continued their efforts, and each maintains combined sewer overflow reduction programs today.

Under existing conditions, most stormwater runoff from the study area drains to 12 sub-basins (Exhibits 4-1 to 4-3) and discharges to Puget Sound via the West Point WWTP or to Elliott Bay through either the separated or low-flow diversion storm drainage system or as part of a combined sewer system overflow. A small portion of the study area discharges to Lake Union through a separated storm drainage system. The pipes within these drainage systems are owned and maintained by private entities, King County, or SPU. An overview of the relationships between the drainage sub-basins, conveyance systems, outfall structures, and receiving waters in the study area is presented in Exhibit 4-4.

There are currently three main types of drainage systems within the study area: a separated storm drainage system, a low-flow diversion drainage system, and a combined sewer system. These systems are described in the following sections.

4.2.1 Separated Storm Drainage System

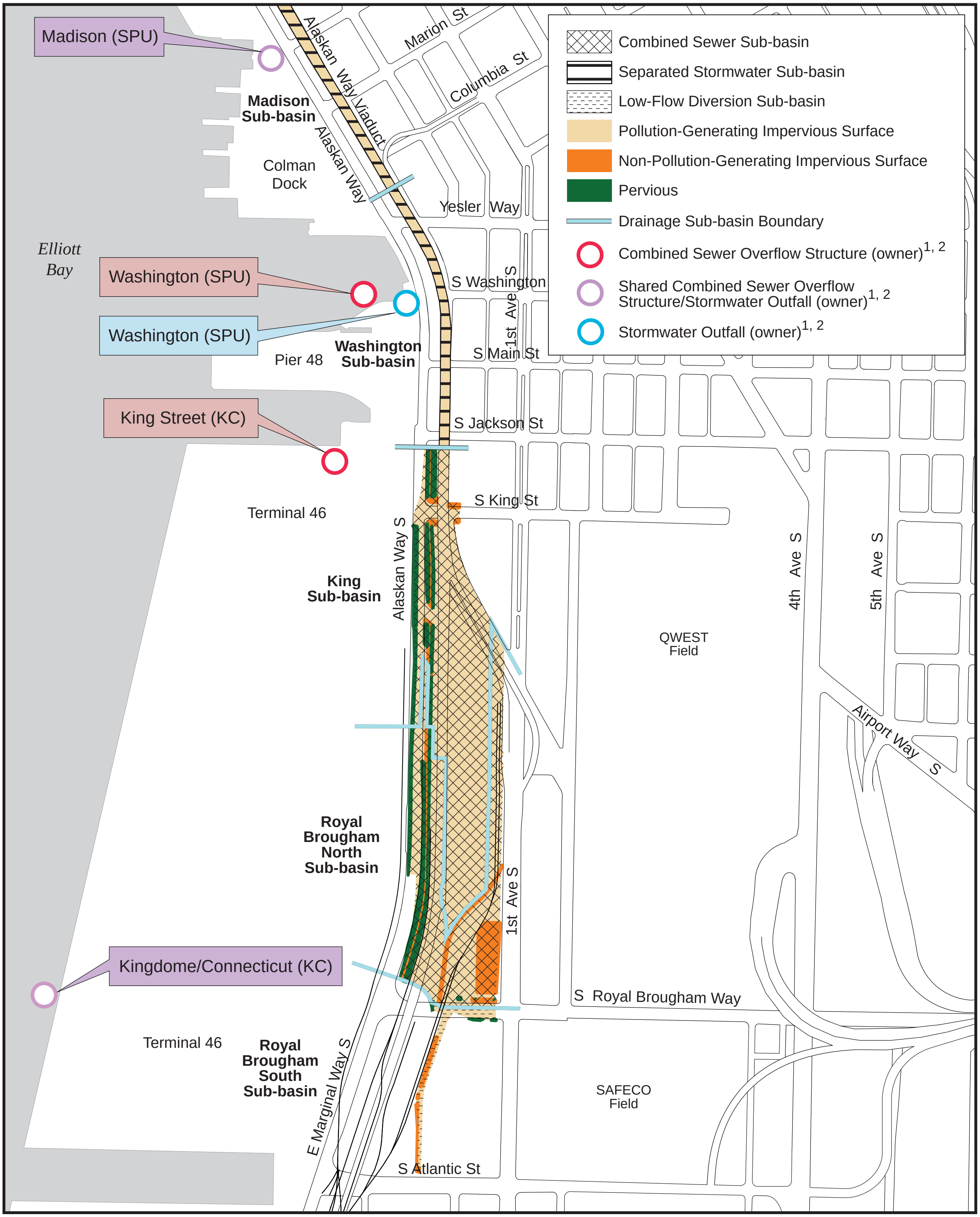
The separated storm drainage system typically collects stormwater from the study area and conveys it to stormwater outfalls, where it is discharged without treatment to either Elliott Bay or Lake Union. Some of the sub-basins drain stormwater to shared stormwater outfalls/combined sewer overflow structures but are independent of the larger combined sewer system.

4.2.2 Low-Flow Diversion Drainage System

The low-flow diversion system regulates the flow of stormwater into the combined sewer system with a gate operated by King County. During heavy rains, if the water surface elevation in the combined sewer system reaches a set point, King County closes the gate. At this point, stormwater is discharged to Elliott Bay without treatment.

4.2.3 Combined Sewer System

The combined sewer system collects stormwater runoff from the study area and conveys it to the City's combined sewer system, where it mixes with sewage. Water within this system is managed using diversion structures and regulators that connect to the County's regional combined sewer system. The County's regional wastewater system serves approximately 420 square miles (268,800 acres) and 1.4 million people in urban King County and parts of Snohomish and Pierce Counties (HDR 2007). The City's combined sewer system constitutes about 7 percent of the County's service area (King County 2009c), or approximately 29 square miles (18,800 acres).



554-1585-030/CC(07) 6/30/10

N

0 600

SCALE IN FEET

Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 4-1
Existing Drainage Configuration - South

554-1585-030/CC(07) 6/30/10

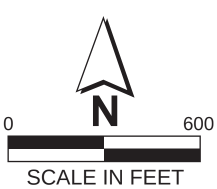
Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 4-2
Existing Drainage Configuration - Central

554-1585-030/CC(07) 6/30/10



Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 4-3
Existing Drainage Configuration - North

Exhibit 4-4. Study Area Drainage Overview

Sub-basin (Type)	Outfall/Overflow Structure (1) Primary Outfall (2) Overflow [1] (3) Overflow [2]	Outfall/Overflow Structure Owner (Type)	Existing Water Quality Treatment	Receiving Water
Royal Brougham South (low-flow diversion[1])	(1) West Point	KC (WWTP)	WWTP	Puget Sound
	(2) Kingdome/ Connecticut	SPU/KC[2] (shared[3])	None	Elliott Bay
Royal Brougham North (combined)	(1) West Point	KC (WWTP)	WWTP	Puget Sound
	(2) Kingdome/ Connecticut	SPU/KC[2] (shared[3])	None	Elliott Bay
King (combined)	(1) West Point	KC (WWTP)	WWTP	Puget Sound
	(2) King Street	KC (combined)	None	Elliott Bay
Washington (storm)	Washington	SPU (storm)	None	Elliott Bay
Madison (storm)	Madison	SPU (shared[3])	None	Elliott Bay
Seneca (storm)	Seneca	SPU (storm)	None	Elliott Bay
University (storm)	University	SPU (shared[3])	None	Elliott Bay
Pike (combined)	(1) West Point	KC (WWTP)	WWTP	Puget Sound
	(2) Elliott West	KC (TP[4])	TP[4]	Elliott Bay
	(3) Denny Way	KC (combined)	None	Elliott Bay
	(4) University	SPU (shared[3])	None	Elliott Bay
Pine (storm)	Pine	SPU (storm)	None	Elliott Bay
Vine (combined)	(1) West Point	KC (WWTP)	WWTP	Puget Sound
	(2) Elliott West	KC (TP[4])	TP[4]	Elliott Bay
	(3) Denny Way	KC (combined)	None	Elliott Bay
	(4) Vine Street	SPU (combined)	None	Elliott Bay
Dexter (combined)	(1) West Point	KC (WWTP)	WWTP	Puget Sound
	(2) Elliott West	KC (TP[4])	TP[4]	Elliott Bay
	(3) Denny Way	KC (combined)	None	Elliott Bay
	(4) Dexter Street	KC (combined)	None	Lake Union
Broad (storm)	Broad (storm)	SPU (storm)	None	Lake Union

Note: KC = King County; SPU = Seattle Public Utilities; TP = wet-weather treatment; WWTP = wastewater treatment plant.

1. Low-flow diversion sub-basins regulate stormwater flow into the combined sewer system with an actuated gate operated by King County. During heavy rains, if the water surface elevation in the combined sewer reaches a set point, the gate is closed and stormwater is discharged directly to Elliott Bay.
2. The Kingdome/Connecticut outfall structure has shared ownership between the City and King County. The outfall pipe is owned and maintained by the City, the storm drain flows are considered City discharges, and the combined sewer overflows are King County discharges.
3. Shared outfalls discharge both separated stormwater runoff and combined sewer overflows.
4. During wet weather, the Elliott West Combined Sewer Overflow Control Facility provides primary treatment and disinfection to flows and then discharges them to Elliott Bay.

In general, the City manages diversion structures, which consist of weirs and/or orifices that passively control the amount of flow. The County manages several regulators within the study area, which typically contain gate valves that are actively controlled to change the combined sewer flow rates (HDR 2007). The County's system includes large interceptor (or collector) pipes that convey the sewage/stormwater mixture to the WWTP during normal flow conditions. This wastewater is treated at the WWTP before being discharged to Puget Sound. The main collector pipe serving the study area is known as the Elliott Bay Interceptor (EBI). When flows exceeds the capacity of the EBI, typically during heavy rain events, diversion structures and regulators divert the flows to backup wet-weather treatment facilities or discharge the untreated diluted wastewater directly to combined sewer overflow structures that drain to Elliott Bay and Lake Union.

Exhibits 4-5 and 4-6 summarize the frequency and volumes of recorded untreated combined sewer overflow events at County and City outfalls, respectively.

Exhibit 4-5. Untreated King County Combined Sewer Overflow Events

		2007		2008	
Receiving Water	Outfall	Number of Events	Total Volume (million gallons)	Number of Events	Total Volume (million gallons)
Lake Union	Dexter	9	28.99	3	3.60
Elliott Bay	Denny	1	29.07	2	0.08
Elliott Bay	King	6	25.38	3	0.82
Elliott Bay	Kingdome/ Connecticut	6	28.56	1	0.23

Sources: King County 2007, 2008, 2009b.

Exhibit 4-6. Untreated City of Seattle Combined Sewer Overflow Events

		2005		2006	
Receiving Water	Outfall	Number of Events	Total Volume (million gallons)	Number of Events	Total Volume (million gallons)
Elliott Bay	Vine	3	17.02	4	0.78
Elliott Bay	University	3	22.42	1	0.35
Elliott Bay	Madison	3	9.1	5	1.62
Elliott Bay	Washington	0	0	1	0.12

Source: Tetra Tech, Inc. 2008.

4.3 Receiving Waters and Tributary Areas

4.3.1 Elliott Bay

Elliott Bay makes up the eastern portion of central Puget Sound. Although this estuary is up to 590 feet deep (Ecology 1994), it is shallow in the nearshore and in the areas where the outfalls discharge. A more detailed description of the nearshore environment of Elliott Bay is provided in Appendix N, Wildlife, Fish, and Vegetation Discipline Report.

The Duwamish Waterway flows into the southern portion of Elliott Bay and is the primary source of fresh water to the bay. The Duwamish Waterway is tidally influenced and has a variable salinity gradient that depends on river flow and tidal fluctuations. The southern portion of the bay is within Water Resource Inventory Area (WRIA) 9, while the northern areas are part of WRIA 8. Residence time of fresh water in the Inner Harbor varies from 1 to 10 days depending on the weather. Based on the results of numerous studies, estuarine water in Elliott Bay generally circulates counterclockwise. Fresh water enters from the Duwamish River, moves north along the Inner Harbor, and then flows out to Puget Sound (Ecology 1995; URS Engineers and Evans-Hamilton 1986). Water currents in the Inner Harbor are generally slow, and velocities are typically oriented parallel to the faces of downtown waterfront piers (Sillcox et al. 1981).

Ecology has designated Elliott Bay to be protected for the following uses: excellent aquatic life, shellfish harvesting, primary contact recreation, wildlife habitat, commerce/navigation, boating, and aesthetics (WAC 173-201A). Elliott Bay is listed on Ecology's 303(d) water quality list (Ecology 2009) for exceeding the criteria for fecal coliform bacteria. No total maximum daily loads (TMDLs) for pollutants of concern have been prepared for Elliott Bay. In addition, the nearshore sediments of Elliott Bay and the Duwamish Waterway contain high concentrations of various metals and chemical compounds that are considered pollutants, which are discussed in Section 4.4, Nearshore Sediments.

The Duwamish Waterway is included on the 303(d) list for exceeding the criteria for fecal coliform bacteria and dissolved oxygen and has a designated TMDL for ammonia. A portion of the Duwamish Waterway near the proposed construction staging areas is also undergoing cleanup as a Superfund site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Stormwater runoff from the south portal area and the existing Alaskan Way Viaduct drains to Elliott Bay via City stormwater outfalls and shared City stormwater outfalls/combined sewer overflow structures (see Exhibits 4-1 and 4-2). These outfalls drain Royal Brougham South, Royal Brougham North, Washington, Madison, Seneca, University, Pike, and Pine sub-basins. Other combined sewer overflow structures at King Street and Vine Street also discharge to Elliott Bay when capacity in the combined sewer system conveyance pipe is exceeded during wet weather. Under normal operating conditions, the contributing flows for these sub-basins are treated at the West Point WWTP.

Royal Brougham South Sub-basin

The study area is located in two Royal Brougham sub-basins, Royal Brougham South and Royal Brougham North, located between S. Holgate Street and Railroad Way S. (see Exhibit 4-1). The Royal Brougham South sub-basin, 0.8 acre of which lies within the study area, is managed by low-flow diversion. As discussed in Section 4.2.2, low-flow diversion sub-basins are managed by regulating the flow of stormwater into the combined sewer system with a gate operated by King County. When the water surface elevation in the combined sewer system reaches a set point, King County closes the gate, at which point, stormwater is discharged to Elliott Bay without treatment. When the low-flow diversion gate is closed, stormwater runoff from the Royal Brougham South sub-basin is collected in a stormwater drainage system that conveys stormwater to the 72-inch-diameter shared Kingdome/Connecticut stormwater outfall/combined sewer overflow structure, from which it is discharged to Elliott Bay with no treatment.

King County operates the Kingdome/Connecticut (Royal Brougham) regulator as part of the EBI system to regulate combined sewer overflow events that occur at the Kingdome/Connecticut outfall. King County plans to construct a new wastewater treatment facility in the vicinity of Royal Brougham by the year 2026. This facility is intended to treat combined sewer flows from the Royal Brougham and King Street sub-basins.

In addition to the Kingdome/Connecticut combined sewer overflow structure, King County operates the King and Denny combined sewer overflow structures, which receive runoff from the study area and drain to Elliott Bay. These combined sewer overflow structures are discussed in detail in Section 4.2.3. The Royal Brougham North combined sewer sub-basin is discussed in detail in Section 4.3.3.

Washington Sub-basin

The Washington sub-basin includes the existing Alaskan Way Viaduct between S. King Street and Yesler Way (see Exhibit 4-1), which makes up approximately 1.1 acres of the study area. As part of the City's Elliott Bay partial separation project, completed in the early 1990s, stormwater runoff in this area of the sub-basin was separated from the combined sewer system and is now collected and discharged via a storm drainage system. As a result, stormwater runoff from this portion of the sub-basin discharges to Elliott Bay via a 72-inch-diameter stormwater outfall with no water quality treatment (see Exhibit 4-1).

A second outfall at S. Washington Street, located just north of the stormwater outfall, functions as an overflow for the City's combined sewer system (see Exhibit 4-1). Under existing conditions, no stormwater runoff from the study area flows to this outfall. In addition to the Washington combined sewer overflow structure, the City also maintains shared stormwater outfall/combined sewer overflow structures at Madison and University Streets and a combined sewer overflow structure at Vine Street within the study area.

Madison Sub-basin

Approximately 1.2 acres of the study area lie within the Madison sub-basin, which includes the existing viaduct (see Exhibits 4-1 and 4-2). As part of the City's Elliott Bay partial separation project, completed in the early 1990s, stormwater runoff in this portion of the sub-basin was separated from the combined sewer system and is now collected and discharged in a storm drainage system. As a result, stormwater runoff from this area discharges untreated to Elliott Bay via a 60-inch-diameter shared stormwater outfall/combined sewer overflow structure (see Exhibit 4-2). This outfall is also a City combined sewer overflow structure; estimated discharge volumes and frequencies of combined sewer overflow are shown in Exhibit 4-6.

Seneca Sub-basin

The Seneca sub-basin includes 0.4 acre of the existing viaduct located between Spring Street and University Street (see Exhibit 4-2). Stormwater runoff from this sub-basin discharges untreated to Elliott Bay via a 10-inch-diameter stormwater outfall. None of the stormwater runoff from this sub-basin is diverted to the West Point WWTP.

University Sub-basin

The University sub-basin is located in the central portion of downtown and collects stormwater runoff from approximately 0.9 acre of the existing viaduct between Union and University Streets (see Exhibit 4-2). Stormwater runoff in this portion of the sub-basin was separated from the combined sewer system as part of the City's Elliott Bay partial separation project completed in the early 1990s. As a result, stormwater from this area is now collected and discharged untreated to Elliott Bay. This stormwater runoff discharges via a 48-inch-diameter shared stormwater outfall/combined sewer overflow structure with a 24-inch-diameter drop structure built into the seawall at University Street. This outfall serves as a City combined sewer overflow structure; estimated discharge volumes and frequencies of combined sewer overflow are shown in Exhibit 4-6.

Pine Sub-basin

The Pine sub-basin, which covers approximately 2 acres of the study area, is located between Pike Street and Lenora Street (see Exhibit 4-2). The existing viaduct and local surface streets make up most of the land use in this sub-basin. Stormwater runoff from this sub-basin discharges untreated to Elliott Bay via a 16-inch-diameter stormwater outfall. None of the stormwater runoff from this sub-basin is diverted to the West Point WWTP.

4.3.2 Lake Union

Lake Union, which is part of WRIA 8, is located north of the study area, in a highly urbanized watershed. Within the study area, only the Broad sub-basin has a dedicated outfall to Lake Union. In addition, the Dexter sub-basin, discussed in detail in Section 4.3.3, has a combined sewer overflow structure that can discharge to Lake Union. The water quality of Lake Union is influenced by freshwater inflows from Lake Washington and discharges from storm drains and combined sewer overflows. The lake represents a transitional area between the fresh waters of Lake Washington and the marine waters of Puget Sound. At depth, water quality is also influenced by saline water introduced through the navigation locks. During the summer (primarily July, August, and September), a layer of saline water with a very low concentration of dissolved oxygen forms along the bottom of Lake Union (Hansen et al. 1994). The saline water and summer lake water temperature cause stratification of the water column, which inhibits mixing of the surface and bottom waters during summer months (CH2M Hill 1999). Typically, the anoxic bottom layer in Lake Union rapidly breaks up during the fall, along with the thermocline in Lake Washington and Lake Union.

Ecology has designated the following uses for protection in Lake Union: core summer habitat, excellent primary contact recreational uses, water supply (domestic, industrial, agricultural, and stock), wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics (WAC 173-201A). Lake Union has been listed on Ecology's 303(d) water quality Category 5 list (Ecology 2009) for exceeding the criteria for aldrin, fecal coliform bacteria, lead, and total phosphorus. It has also exceeded the sediment bioassay criteria, as described in Section 4.4, Nearshore Sediments.

Broad Sub-basin

The Broad sub-basin is located along Broad Street and collects stormwater from approximately 4.9 acres of the study area (see Exhibit 4-3). Land use in this sub-basin is primarily surface streets. Stormwater runoff is collected in a separated storm drainage system and discharged without treatment to Lake Union via a 30-inch-diameter stormwater outfall.

4.3.3 Puget Sound

Puget Sound is a large marine water body that covers approximately 900 square miles, including Elliott Bay. Other than Elliott Bay, no portion of Puget Sound within the study area has been listed on Ecology's 303(d) water quality list

(Ecology 2009). No TMDLs have been prepared for Puget Sound in the vicinity of the study area.

Under normal operating conditions, stormwater runoff from the King, Pike, Vine, Denny, and Dexter sub-basins is collected in combined sewer pipes, treated at the West Point WWTP, and discharged to Puget Sound through a deep water outfall. During large storm events, when the combined sewer capacity is exceeded, flows from the combined sewer are diverted to backup wet-weather treatment facilities or are discharged untreated as combined sewer overflows to Elliott Bay and/or Lake Union.

Royal Brougham North Sub-basin

The Royal Brougham North sub-basin covers approximately 8.3 acres of the study area and includes the existing viaduct between Railroad Way S. and S. King Street (see Exhibit 4-1). Stormwater runoff in this sub-basin is collected by the combined sewer system, conveyed to the West Point WWTP for treatment, and discharged to Puget Sound. During large storm events, combined stormwater runoff is discharged untreated through a 72-inch-diameter pipe to Elliott Bay as a combined sewer overflow.

King Sub-basin

The King sub-basin covers approximately 10.3 acres of the study area and includes the existing viaduct between Railroad Way S. and S. King Street (see Exhibit 4-1). The King sub-basin is part of a larger sub-basin that extends east of Interstate 5 (I-5). Stormwater runoff in the King sub-basin is collected in separated storm pipes; however, they connect to the combined sewer system upstream of a diversion structure. Therefore, under normal operating conditions, stormwater runoff from this sub-basin is diverted to the EBI, conveyed to the West Point WWTP for treatment, and discharged to Puget Sound. During large storm events, combined stormwater runoff is discharged untreated in a 48-inch-diameter pipe to Elliott Bay as a combined sewer overflow.

Pike Sub-basin

The Pike sub-basin covers approximately 0.6 acre of the study area along the existing viaduct (see Exhibit 4-2). Runoff from this sub-basin is collected in combined sewer pipes and conveyed to the Pike Street adit structure, a vault that contains transitional pipes conveying flow from the University regulator structure to the EBI. During normal operations, stormwater runoff from this sub-basin is collected in the combined system, conveyed to the West Point WWTP for treatment, and discharged to Puget Sound. During wet weather, flows from this sub-basin are diverted to the Elliott West Combined Sewer Overflow Control Facility, a wet-weather treatment facility constructed in 2005. The Elliott West facility provides primary treatment and disinfection to flows and then discharges them to Elliott Bay. When the Elliott West facility is at capacity, untreated overflows are discharged to Elliott Bay through the County's Denny Way regulator structure. Flows from the Pike sub-basin may also be discharged as a combined sewer overflow through the City's University outfall structure.

Vine Sub-basin

The Vine sub-basin includes approximately 2.2 acres of the study area in the northern portion of the existing viaduct (see Exhibit 4-2). Within this portion of the sub-basin, the existing Alaskan Way is located partially on the viaduct structure and partially in the Battery Street Tunnel. Stormwater runoff from surface streets and the portion of the viaduct exposed to precipitation is collected in the combined system. During normal operations, stormwater runoff from this sub-basin is conveyed to the West Point WWTP for treatment and discharged to Puget Sound. During large storm events, flows are either treated at the Elliott West Combined Sewer Overflow Control Facility (providing primary treatment and disinfection) and then discharged to Elliott Bay. When the Elliott West facility is at capacity, untreated overflows are discharged to Elliott Bay through the County's Denny Way regulator structure. Flows from the Vine sub-basin may also be discharged untreated via the City's 24-inch-diameter Vine Street outfall as a combined sewer overflow. Estimated discharge volumes and frequencies of combined sewer overflow from the Vine Street outfall are shown in Exhibit 4-6.

Dexter Sub-basin

The Dexter sub-basin is located in the vicinity of the north portal of the proposed bored tunnel and currently includes approximately 20 acres of the study area along Aurora Avenue, Dexter Avenue, and Mercer Street (see Exhibit 4-3). During normal operations, runoff from this area is collected in combined sewer pipes, conveyed north in pipes under streets near the western shore of Lake Union to the West Point WWTP for treatment, and discharged to Puget Sound. During large storm events, flows can be routed to treatment at the Elliott West Combined Sewer Overflow Control Facility (providing primary treatment and disinfection) and then discharged to Elliott Bay through the Elliott West outfall. When the Elliott West facility is at capacity, untreated overflows are discharged to Elliott Bay through the County's Denny Way regulator structure. In addition, runoff flows from the Dexter sub-basin may potentially be stored in the Mercer Tunnel until capacity increases enough for the flows to be discharged back into the combined system. During large storm events, runoff from the Dexter sub-basin may also be discharged untreated to Lake Union as a combined sewer overflow via the County's 42-inch-diameter Dexter Street combined sewer overflow structure.

4.4 Nearshore Sediments

The Washington State Sediment Management Standards use two different levels of criteria for Puget Sound sediment: the sediment quality standards (SQS) and the cleanup screening levels (CSL). The SQS set the limits for sediment quality that will result in no adverse effects on biological resources or no significant risk to human health. The CSL denote sediment quality that may result in minor adverse effects. The SQS serve as the objective for all cleanup actions. However, factors such as cost, technical feasibility, and net environmental effects may allow the goal for a given cleanup project to be set within the range of a designated CSL (Ecology 2008).

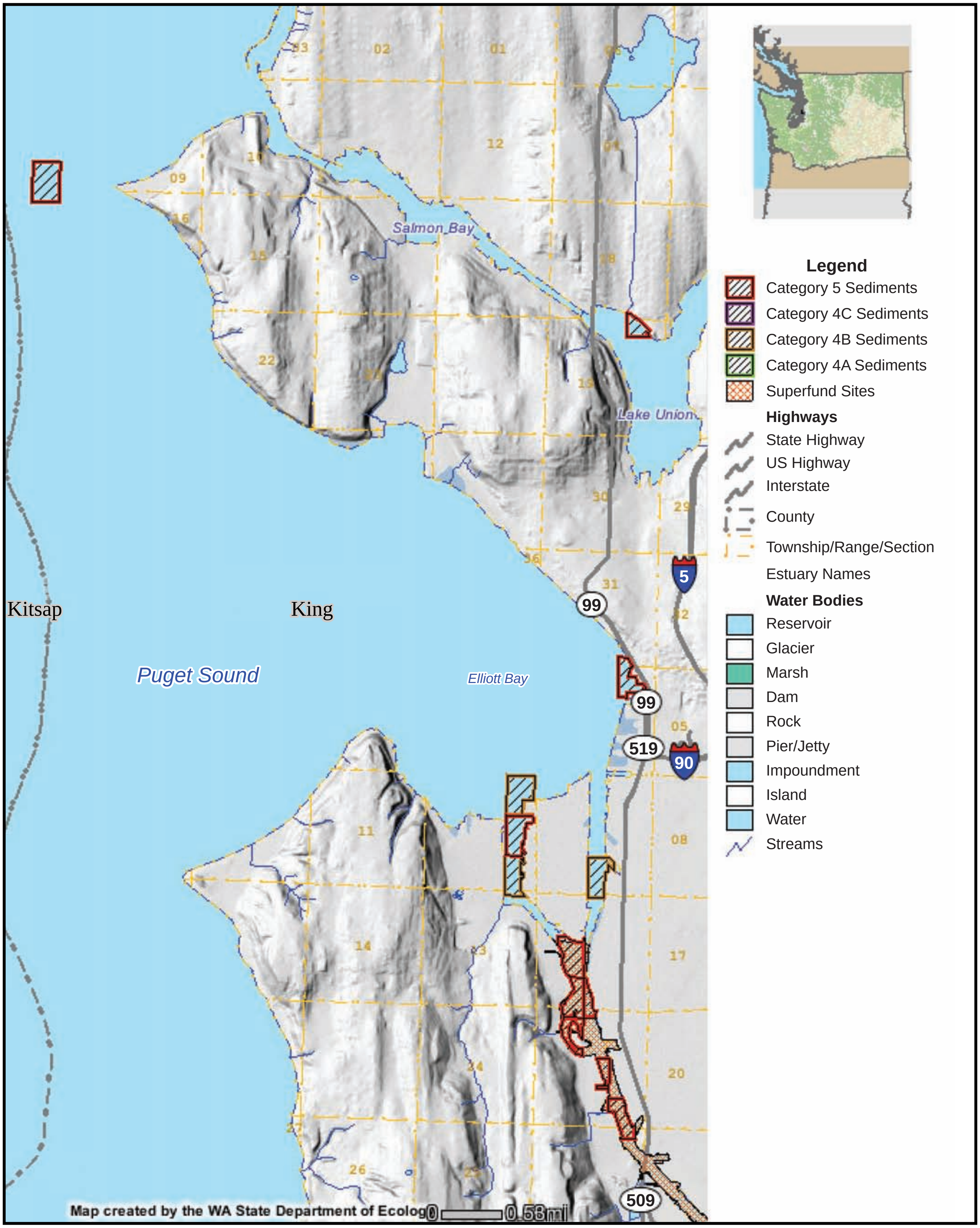
Sediments in central Puget Sound, the Elliott Bay waterfront area, and Lake Union contain various pollutants at concentrations that exceed the SQS and CSL. Given that the pollutants most common to urban roadway runoff include copper, zinc, and petroleum hydrocarbons, it is likely that the wider array of pollutants found in these sediments have been generated by additional sources, such as industrial activities or sewage discharges. Exhibit 4-7 indicates the locations near the study area that are included on Ecology's sediment quality 303(d) list as Category 4 or Category 5 for contaminated sediments. Existing information on known contaminants in nearshore sediments in these areas is described below.

4.4.1 Elliott Bay

Sediment Quality Conditions

Elliott Bay nearshore sediments contain high concentrations of various metals and chemical compounds that are considered pollutants (Romberg et al. 1984; EPA 1988; Metro 1988b, 1989, 1993; Tetra Tech, Inc. 1988; Hart Crowser 1994; King County 1994; Norton and Michelson 1995; Ecology 1995). These contaminants include mercury, silver, lead, zinc, copper, PAHs, PCBs, and other metals and organic compounds. Nearshore sediments along the project area outside the wave-action zone have a high percentage of fine sediment (40 to 70 percent if not disturbed by vessel activity, cap placement, or dredging).

Nearshore sediments are often further classified as either surface or subsurface and may have different levels of contamination. Within the study area, surface and subsurface sediments contain contaminants at concentrations that exceed the applicable SQS and CSL. These sediments have been listed on the state's 303(d) list for exceeding standards for numerous pollutants of concern. Exceedances of sediment criteria are generally associated with previous industrial activities and stormwater and combined sewer overflows.



554-1585-030/CC(07) 6/30/10

Source: http://apps.ecy.wa.gov/wqawa2008/viewer.htm.

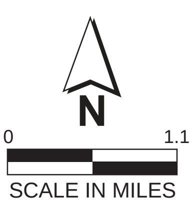


Exhibit 4-7
Project Area Receiving Waters - Contaminated Sediments

Sediment Quality Remediation Projects

Several sediment remediation projects have been completed to improve the quality of nearshore sediments along Elliott Bay. These sediment remediation projects have involved placing clean sediment (generally sand) on top of contaminated sediment—a method called *sediment capping*. The cap of clean sediment protects benthic organisms from coming into contact with contaminated sediment and prevents or reduces suspension of the contaminated sediments into the water column. Within the study area, sediment remediation projects have been completed at Pier 51 (under a portion of the ferry terminal in 1989), Piers 53to 55 (1992), and Denny Way (1992). Ecology determined that discharges from stormwater outfalls and combined sewer overflow structures do not contain enough pollutants to result in recontamination of remediated sediments at levels higher than the applicable CSL (Ecology 1995). However, there are numerous outfalls in the vicinity that may be ongoing sources of pollutants. Recontamination may also occur from nonpoint sources such as spills, creosote pilings, and bulkheads.

4.4.2 Lake Union

Washington State has not promulgated chemical standards for freshwater sediment. However, chemicals of potential concern in the south end of Lake Union in the vicinity of the Broad stormwater outfall and the Dexter combined sewer overflow structure include naphthalene, PCBs, PAHs, cadmium, copper, lead, mercury, zinc, nickel, antimony, chromium, and various other organic compounds. Lake Union is also on the state's 303(d) list (Ecology 2009) for failing the freshwater sediment bioassay test.

4.4.3 Central Puget Sound

Central Puget Sound nearshore sediments contain concentrations of several different contaminants at concentrations exceeding the SQS and CSL. The area at the West Point WWTP outfall has been placed on the 2008 303(d) list (Ecology 2009) for failing the sediment bioassay test. Contaminants that exceed the SQS and CSL in the vicinity of the West Point WWTP outfall include mercury, total PCBs, chrysene, and various other organic compounds.

Chapter 5 Operational Effects, Mitigation, and Benefits

This chapter describes the potential operational effects and benefits of the Bored Tunnel Alternative on surface water, as well as proposed mitigation for any potential adverse effects of the Bored Tunnel Alternative. A land use analysis, which compares the existing conditions against the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative and quantifies the hydrologic effects as a change in impervious surface area, is summarized in Section 5.1. A pollutant loading analysis quantifying water quality as a change in annual loading for the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative compared to existing conditions is summarized in Section 5.2. Potential operational effects of the Viaduct Closed (No Build Alternative) and the effects of each project element associated with the Bored Tunnel Alternative are described in Sections 5.3 and 5.4, respectively.

5.1 Land Use and Hydrologic Analysis

Removing vegetation and increasing the amount of impervious surface in a watershed can change the hydrologic cycle by reducing infiltration, increasing the volume of surface runoff, and increasing the peak flow rate generated by a storm event. Through this hydrologic relationship, land development can potentially result in increased flooding, streambank erosion, aquatic habitat destruction, increased pollutant load, and reduced baseflow in streams and wetlands (WSDOT 2008b). In urban areas like the Bored Tunnel Alternative study area, the land cover has been mostly impervious for over 100 years, and runoff is discharged to large receiving waters (Elliott Bay, Lake Union, and Puget Sound) that are not as susceptible to minor changes in hydrology. However, increases in impervious surface within the study area could pose a risk of increased pollutant loads and increased volume and/or frequency of combined sewer overflows.

Changes in land use resulting from the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative compared to existing conditions are summarized in Exhibit 5-1. The No Build Alternative would not change the amount of impervious surface within the study area. However, the Bored Tunnel Alternative would increase the amount of total impervious area (TIA) in the study area, specifically in sub-basins that would discharge to the combined sewer system (Exhibits 5-2 through 5-4). To alleviate any potential risk of increased frequency or volumes of combined sewer overflows, detention would be provided as described in Sections 5.4.1 through 5.4.3. Section 5.2 discusses the potential effects of changes in impervious surface on pollutant loads.

Exhibit 5-1. Summary of Land Use Changes

Land Cover	Area [acres] [1] Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
Pervious	3.0–3.0	3.0–3.0	1.7–1.9
Non-PGIS	6.4–7.0	14.8–15.4	17.6–20.2
PGIS	43.3–44.5	35.0–36.1	32.6–33.5
TIA	49.8–51.4	49.8–51.4	50.3–53.6
Total area[2]	52.8–54.5	52.8–54.5	52.8–54.5

Note: PGIS = pollutant-generating impervious surface; TIA= total impervious area

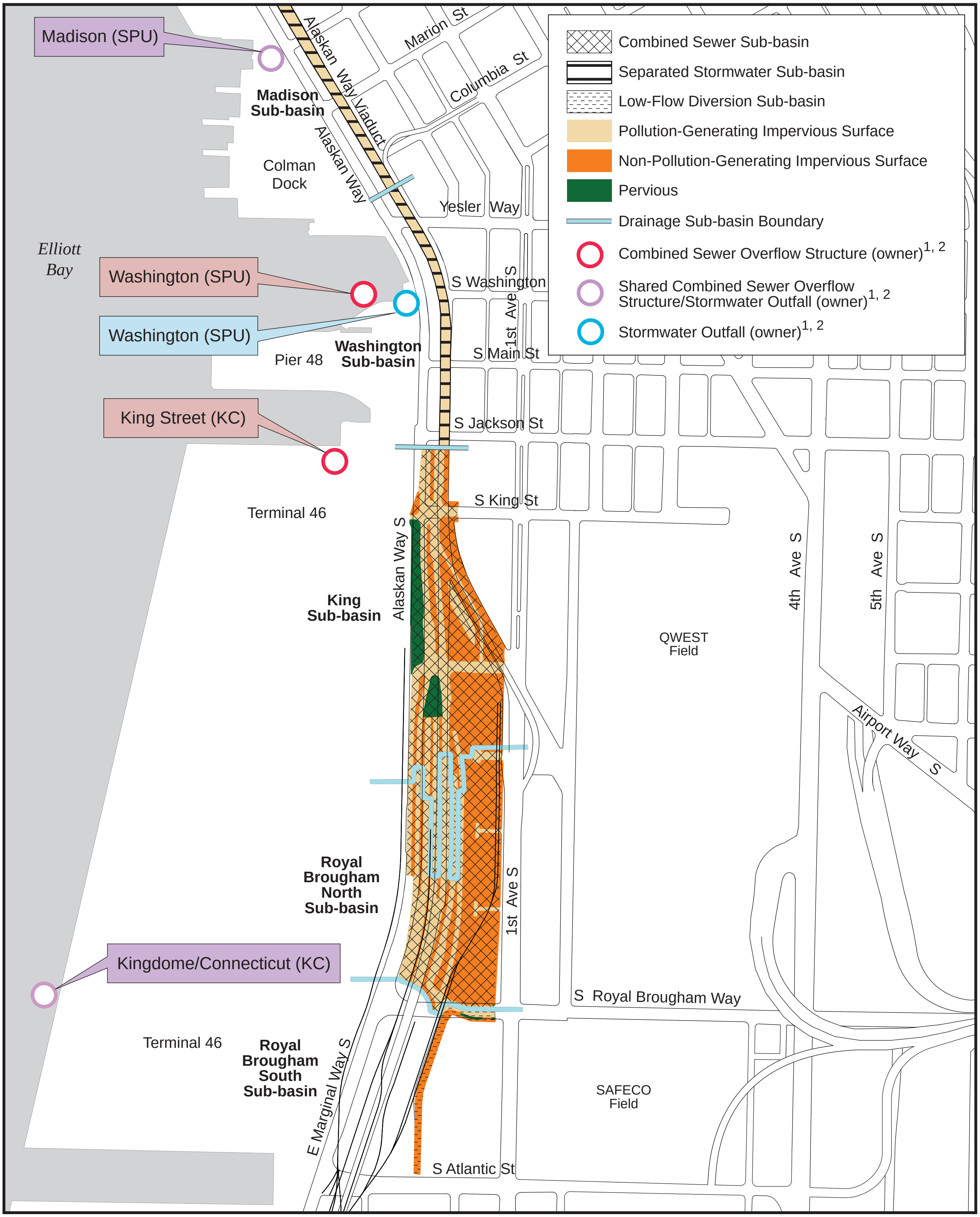
1. Each of the proposed roadway design options in the south and north portal areas have different total areas. This table presents the highest and lowest proposed values for each parameter among the different design option combinations. Subtotals specific to each roadway design option combination are presented in Attachment A.
2. Subtotals for each sub-basin within the separate study area locations are presented in Attachment A.

5.2 Pollutant Loading Analyses

Runoff from streets and highways, particularly in urban environments, contains pollutants that can affect the water quality of the receiving water. Studies conducted on runoff in the Seattle area indicate that highways are a measurable source of suspended solids, metals (zinc and copper), and other pollutants. Pollutant loads in stormwater runoff vary depending on the amount and type of PGIS, traffic volume and average speed, duration and intensity of a storm event, time of year, antecedent weather conditions, and several other factors.

As show in Exhibit 5-5, pollutant loading would decrease relative to existing conditions for both the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative, primarily due to a reduction in PGIS under both alternatives (Exhibit 5-1). Therefore, either alternative would potentially result in a benefit to surface water quality in the study area receiving waters.

The pollutant loading analysis is presented in detail in Attachment A. Detailed discussions of the potential operational effects of each alternative are included in the following sections.



554-1585-030/CC(07) 6/30/10

N

0 600

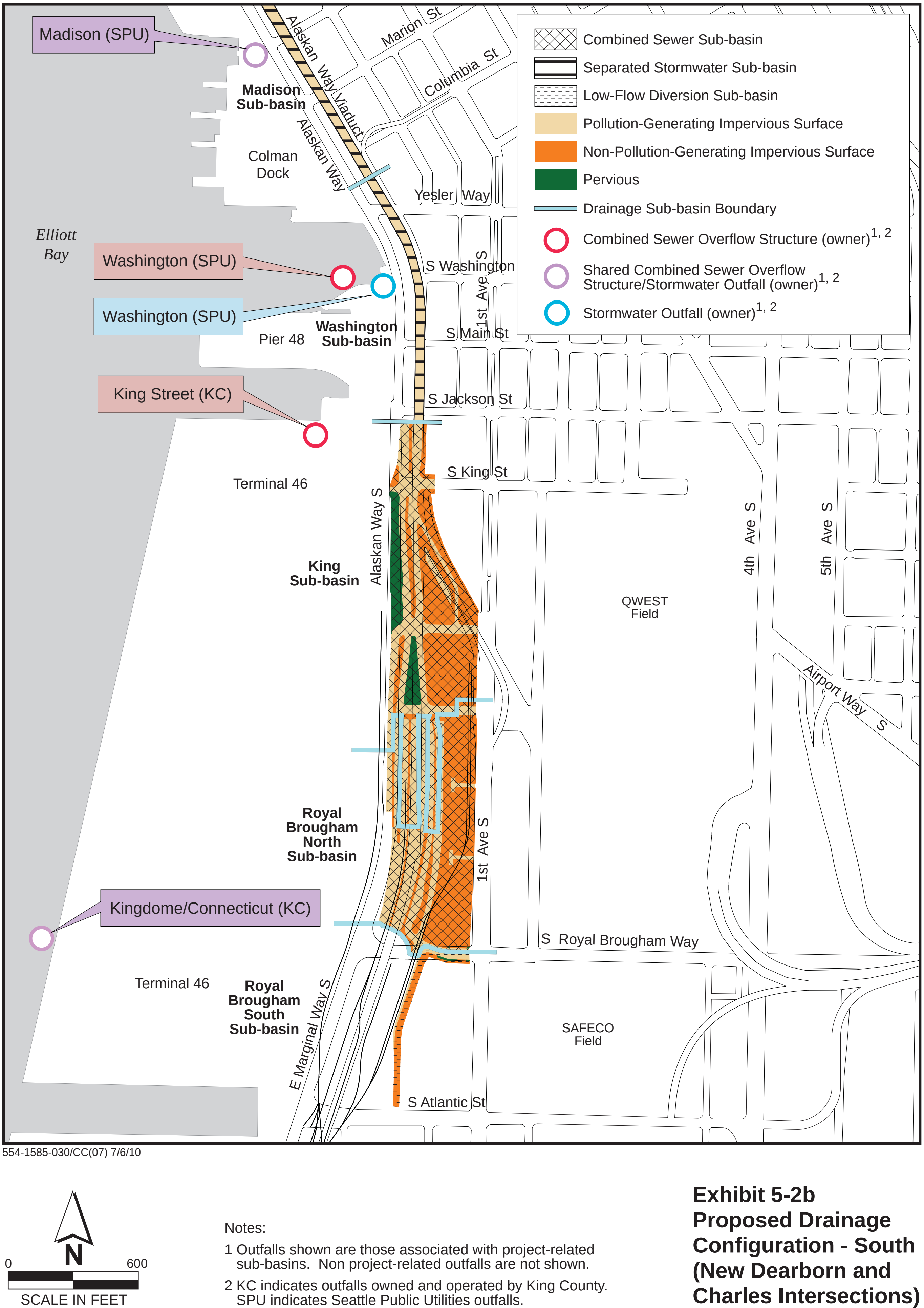
SCALE IN FEET

Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 5-2a
Proposed Drainage Configuration - South (New Dearborn Intersection)

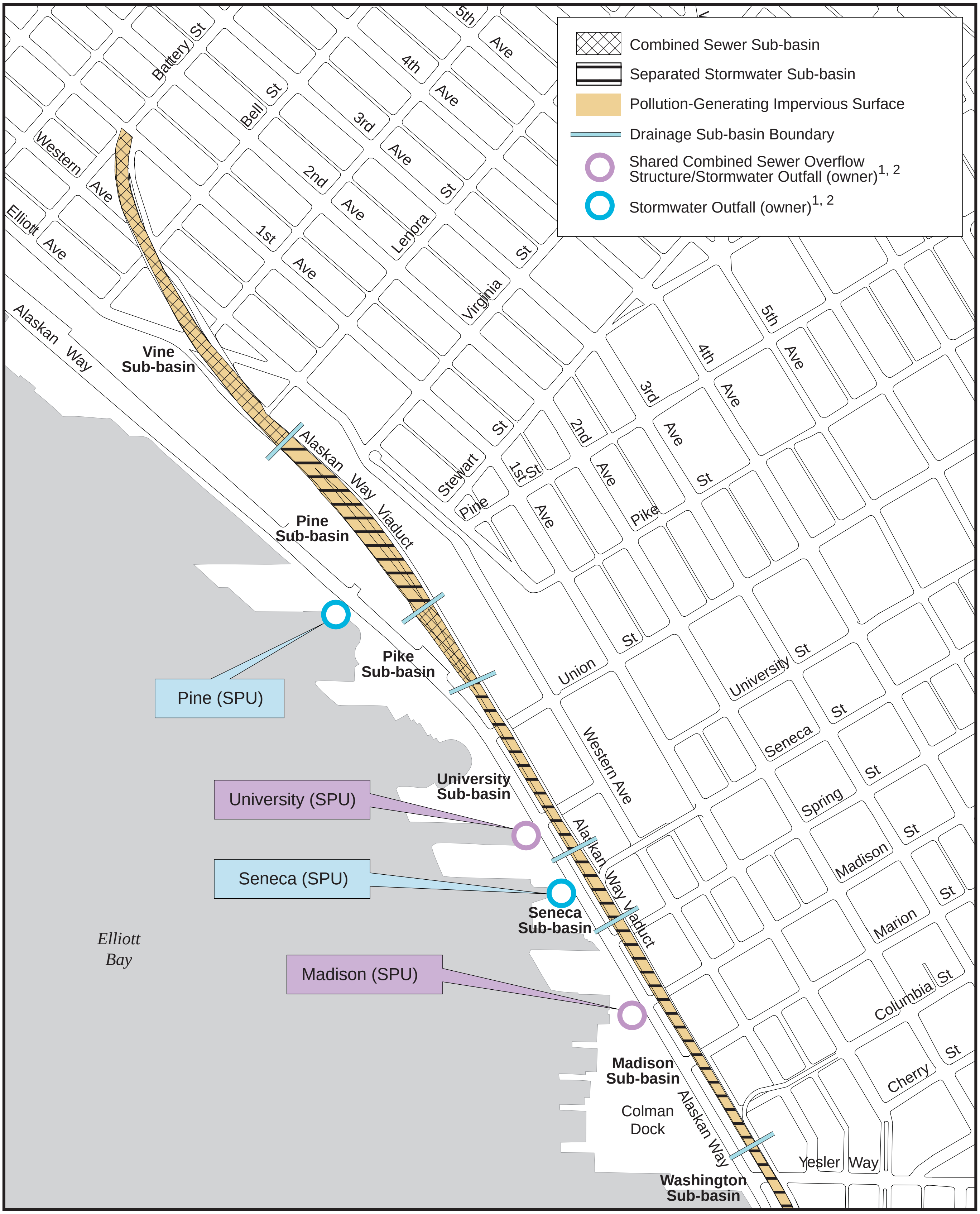


Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 5-2b
Proposed Drainage Configuration - South (New Dearborn and Charles Intersections)



554-1585-030/CC(07) 6/30/10

N

0 600

SCALE IN FEET

Notes:

1 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

2 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 5-3
Proposed Drainage Configuration - Central

554-1585-030/CC(07) 7/6/10

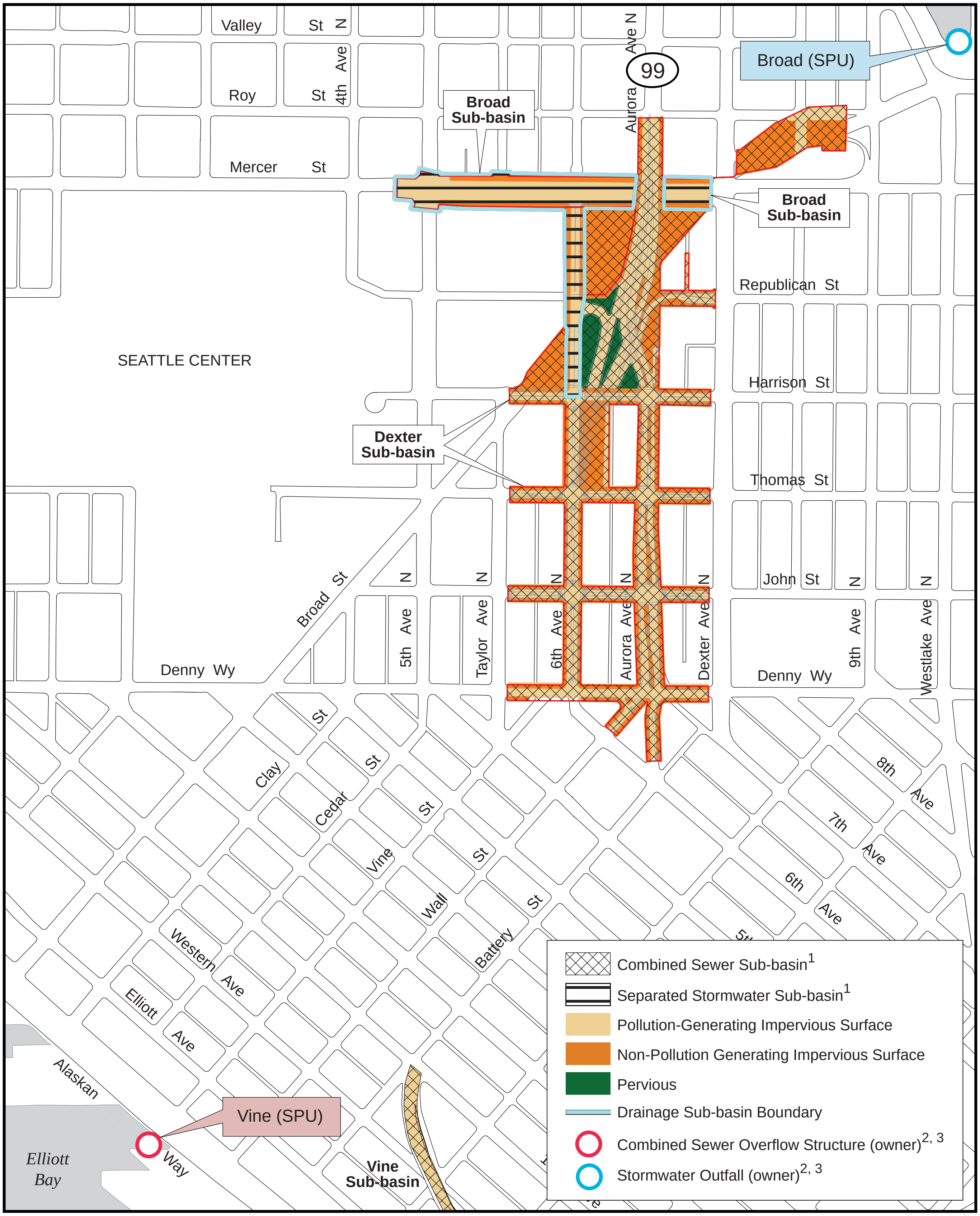
Notes:

1 Separated Storm and Combined Sewer stormwater management scenario shown. The Combined Sewer scenario would direct all runoff to Dexter Sub-basin.

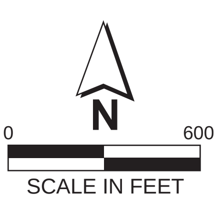
2 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

3 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 5-4a
Proposed Drainage Configuration - North (Curved Sixth Avenue)



554-1585-030/CC(07) 7/6/10



Notes:

1 Separated Storm and Combined Sewer stormwater management scenario shown. The Combined Sewer scenario would direct all runoff to Dexter Sub-basin.

2 Outfalls shown are those associated with project-related sub-basins. Non project-related outfalls are not shown.

3 KC indicates outfalls owned and operated by King County. SPU indicates Seattle Public Utilities outfalls.

Exhibit 5-4b
Proposed Drainage Configuration - North (Straight Sixth Avenue)

Exhibit 5-5. Summary of Pollutant Loading Analysis

Pollutant of Concern	Pollutant Load [pounds/year] [1]		
	Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
TSS	33,300–34,200	26,900–27,800	21,900–25,600
Total copper	6.9–7.1	5.6–5.8	4.7–5.3
Dissolved copper	1.7–1.8	1.4–1.4	1.3–1.3
Total zinc	42.5–43.6	34.3–35.4	28.4–32.6
Dissolved zinc	13.4–13.8	10.8–11.2	9.3–10.3

Note: TSS = total suspended solids

1. Each of the proposed roadway design options in the south and north portal areas have different amounts of PGIS and corresponding pollutant loads. This table presents the highest and lowest calculated values for each parameter among the different design option combinations. Subtotals specific to each roadway design option combination are presented in Attachment A.

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

Two scenarios were evaluated as part of the Viaduct Closed (No Build Alternative):

- Scenario 1 – Unplanned closure of the viaduct for some structural deficiency, weakness, or damage due to a smaller earthquake event.
- Scenario 2 – Catastrophic failure and collapse of the viaduct.

In Scenario 1, it is assumed that the existing viaduct would no longer be pollutant-generating. However, the areas in the remainder of the study area (e.g., the south and north portal areas) would not be changed. As shown in Exhibit 5-5, pollutant loads to surface water generated under this scenario are expected to be lower than the loads under existing conditions. This reduction in pollutant load would be the result of the removal of traffic from the existing viaduct surface.

Scenario 2, a major collapse of the existing viaduct, would likely result in significant short term effects on surface water. As discussed in Appendix P, Earth Discipline Report, there is a high liquefaction hazard along the downtown Seattle waterfront. Therefore, this scenario would potentially result in the collapse of not only the viaduct, but the seawall as well, and the liquefaction of some or all of the ground in the vicinity. Collapse of the sewers in the vicinity would result in the discharge of untreated sewage. The nearshore areas of Elliott Bay would be severely affected by the influx of debris and contaminated soil from beneath the viaduct, and the existing contaminated sediments that currently lie beneath Elliott Bay would potentially be resuspended. In addition, collapse of the existing viaduct would result in a dramatic disruption of the existing stormwater conveyance systems. In the event of a major collapse, the water quality impacts would potentially be short-term, until recovery measures are completed to stabilize the area.

5.4 Operational Effects of the Bored Tunnel Alternative

Overall, the Bored Tunnel Alternative would potentially have a beneficial effect on surface water in the study area. Details regarding potential effects of each project element, generally proceeding from south to north, are provided in the sections below. Potential effects of construction are discussed in Chapter 6.

5.4.1 South Portal

Proposed changes to the land cover in the south portal area under the Bored Tunnel Alternative design options are summarized in Exhibit 5-6. TIA in the south portal area would increase, mostly due to a wider pedestrian and bicycle facility, new sidewalks, and a tunnel operations building. These increases would occur only in areas that discharge runoff to the combined sewer system; however, detention would not be provided for these areas. Modeling has shown that the use of surface water detention in the south portal area would not reduce the potential frequency and/or volume of overflows from the combined sewer system. Therefore, an exception from the peak flow control requirements in the Seattle Stormwater Code has been granted by the City for the south portal area (Seattle 2009b).

Estimated pollutant loads for the south portal area under each Bored Tunnel Alternative design option are summarized in Exhibit 5-7. Total pollutant loads are expected to be reduced in the south portal area due to the decrease in PGIS. Also, for the most of the south portal area, water quality treatment would continue to be provided by discharging runoff to the combined sewer system, similar to existing conditions. In addition, water quality treatment would be provided for approximately 0.3 acre of PGIS in the Royal Brougham South low-flow diversion sub-basin that currently has no on-site treatment. This area would be treated by BMPs selected from the Seattle *Stormwater Manual* (Seattle 2009a) and/or the WSDOT *Highway Runoff Manual* (WSDOT 2008b).

Exhibit 5-6. Bored Tunnel Alternative South Portal Land Use

Sub-basin[1]	Land Cover	Area [acres] New Dearborn Intersection Design Option: Existing Conditions	Area [acres] New Dearborn Intersection Design Option: Bored Tunnel Alternative	Area [acres] New Dearborn and Charles Intersections Design Option: Existing Conditions	Area [acres] New Dearborn and Charles Intersections Design Option: Bored Tunnel Alternative	Proposed Runoff Collection
Royal Brougham South	Pervious	0.02	0.02	0.02	0.02	Low-flow diversion (PGIS treated with on-site BMPs)
	Non-PGIS	0.1	0.5	0.1	0.5	
	PGIS	0.7	0.3	0.7	0.3	
	Total area	0.8	0.8	0.8	0.8	
Royal Brougham North	Pervious	0.6	0.0	0.6	0.0	Combined sewer system
	Non-PGIS	1.1	5.5	1.1	4.4	
	PGIS	6.5	2.9	6.5	3.6	
	Total area	8.3	8.4	8.3	8.0	
King	Pervious	0.7	0.9	0.7	1.0	Combined sewer system
	Non-PGIS	0.3	4.0	0.3	4.5	
	PGIS	9.3	5.3	9.3	5.2	
	Total area	10.3	10.2	10.3	10.6	
Total	Pervious	1.4	0.9	1.4	1.0	
	Non-PGIS	1.5	10.0	1.5	9.4	
	PGIS	16.5	8.4	16.5	9.0	
	Total area	19.3	19.3	19.3	19.3	

Note: BMP = best management practice; PGIS = pollutant-generating impervious surface

1. Sub-basin configurations would be similar to existing drainage patterns. The only addition would be on-site BMPs to provide basic water quality treatment for PGIS in the Royal Brougham South low-flow diversion sub-basin.

Exhibit 5-7. Bored Tunnel Alternative South Portal Pollutant Loading

Pollutant of Concern	Pollutant Load [pounds/year]			
	New Dearborn Intersection Design Option		New Dearborn and Charles Intersections Design Option	
	Existing Conditions	Bored Tunnel Alternative	Existing Conditions	Bored Tunnel Alternative
TSS	12,650	6,306	12,650	6,737
Total copper	2.63	1.32	2.63	1.41
Dissolved copper	0.66	0.33	0.66	0.36
Total zinc	16.12	8.06	16.12	8.61
Dissolved zinc	5.10	2.57	5.10	2.74

Note: TSS = total suspended solids

5.4.2 Bored Tunnel

As discussed in the *Bored Tunnel Corridor Final Conceptual Hydraulic Report* (CH2M Hill 2010), some stormwater is expected to enter the tunnel at each portal area. This water would be pumped to each respective portal and discharged to the combined sewer system. As discussed in Chapter 4, under existing conditions, the project area consists predominantly of impervious surface, and surface water runoff volumes would not be increased by the Bored Tunnel Alternative.

Non-Stormwater Drainage Volumes

Drainage flows are expected to be generated within the bored tunnel from several non-stormwater sources. Chlorinated water would be introduced into the tunnel during testing and operation of the emergency fire suppression system. Chlorinated water would also be used during tunnel washing; however, detergent is not expected to be added to this water. Groundwater seepage would also occur in the tunnel on a continuous basis. The frequencies, rates, and durations of these non-stormwater drainage events are summarized in Exhibit 5-8.

The tunnel would be equipped with pumps to collect this water, directing it to the closest point of discharge near the south portal, where it would be discharged to the City's combined sewer system. The pumps would operate intermittently in response to water level in the sump and would have float controls or other means to regulate on-off operation. Under one possible pumping scheme, the tunnel would be equipped with two 200-gallon-per-minute pumps. Normally only one pump would operate at a time. During periods of high inflow, such as during tests of the fire suppression sprinkler system, flow rates into the tunnel can be as high as 2,500 gallons per minute. However, the design prevents the hydraulic overload of the combined sewer system by limiting the outflow pumps to operate at a combined pumping rate of no more than 400 gallons per minute. Controllable activities that would contribute to the pumping demand, such as tunnel washing and fire suppression system testing, would be limited to dry weather periods in order to reduce the risk of overloading the combined sewer system. In addition, before being pumped from the tunnel, the water would receive pretreatment to satisfy the King County water quality discharge requirements.

Exhibit 5-8. Bored Tunnel Alternative Non-Stormwater Tunnel Flows

Event	Frequency	In-Flow Rate (gallons per minute)	Duration
Tunnel seepage	Continuous	22	Continuous
Tunnel washing	One to two times per year	35 to 70	Several days
Fire suppression valve testing	Once per year	100	Intermittently over several days
Fire suppression sprinkler system testing	Every 5 years	2,500	Intermittent during test period
Fire suppression – major fire event	Unpredictable	Up to 4,000	Unpredictable

Source: CH2M Hill 2010.

5.4.3 North Portal

Proposed changes to the land cover in the north portal area under each Bored Tunnel Alternative design option and stormwater management scenario are summarized in Exhibit 5-9. TIA in the north portal area would increase, mostly due to new sidewalks and a tunnel operations building. To alleviate any potential risk of increased frequency or volumes of combined sewer overflows in areas that discharge runoff to the combined sewer system, peak flow control would be provided in accordance with the requirements of the Seattle Stormwater Code. Flow control would most likely be provided by the installation of one or more on-site or off-site detention facilities.

Under the Separated Storm and Combined Sewer stormwater management scenario, 1.1 acres would shift away from the Dexter sub-basin, which would potentially help to reduce the frequency and/or volume of overflows from the combined sewer system in addition to the proposed peak flow control. Alternatively, under the Combined Sewer stormwater management scenario, approximately 4.9 acres would shift from the Broad sub-basin to the Dexter sub-basin. The additional flow to the combined sewer system resulting from this shift would be addressed through the peak flow control facilities previously discussed.

Estimated pollutant loads for the north portal area under each Bored Tunnel Alternative design option and stormwater management scenario are summarized in Exhibit 5-10. Total pollutant loads are expected to be reduced in the south portal area due to the decrease in PGIS. Also, for runoff discharging to the Dexter sub-basin, water quality treatment would continue to be provided by discharging runoff to the combined sewer system, similar to existing conditions. In addition, on-site water quality treatment would be provided for all PGIS in the Broad sub-basin, which currently has no on-site treatment. This area would be treated by BMPs selected from the Seattle *Stormwater Manual* (Seattle 2009a) and/or the WSDOT *Highway Runoff Manual* (WSDOT 2008b).

Exhibit 5-9. Bored Tunnel Alternative North Portal Land Use

Sub-basin	Land Cover	Area [acres]: Curved Sixth Avenue Design Option			Area [acres]: Straight Sixth Avenue Design Option			Proposed Runoff Collection
		Existing Conditions	Separated Storm and Combined Sewer [1]	Combined Sewer [1]	Existing Conditions	Separated Storm and Combined Sewer [1]	Combined Sewer [1]	
Broad	Pervious	0.5	0.0	0.0	0.5	0.0	0.0	Separated storm (PGIS treated with on-site BMPs)
	Non-PGIS	0.6	1.37	0.0	0.6	1.6	0.0	
	PGIS	3.8	4.47	0.0	3.8	4.4	0.0	
	Total area	***4.9***	***5.8***	***0.0***	***4.9***	***6.0***	***0.0***	
Dexter	Pervious	1.2	0.89	0.9	1.2	0.8	0.8	Combined sewer system
	Non-PGIS	4.3	6.91	8.3	4.8	8.6	9.8	
	PGIS	14.8	11.43	15.9	15.9	11.4	16.1	
	Total area	***20.2***	***19.2***	***25.1***	***21.9***	***20.8***	***26.8***	
Total	Pervious	1.7	0.9	0.9	1.7	0.8	0.8	
	Non-PGIS	4.9	8.3	8.3	5.4	10.1	9.8	
	PGIS	18.5	15.9	15.9	19.6	15.8	16.1	
	Total area	***25.1***	***25.1***	***25.1***	***26.8***	***26.8***	***26.8***	

Note: BMP = best management practice; PGIS = pollutant-generating impervious surface

1. The Separated Storm and Combined Sewer stormwater management scenario and the Combined Sewer stormwater management scenario represent two different proposed stormwater management approaches in the north portal area.

Exhibit 5-10. Bored Tunnel Alternative North Portal Pollutant Loading

Pollutant of Concern	Pollutant Load [pounds/year]					
	Curved Sixth Avenue Design Option			Straight Sixth Avenue Design Option		
	Existing Conditions	Separated Storm and Combined Sewer [1]	Combined Sewer [1]	Existing Conditions	Separated Storm and Combined Sewer [1]	Combined Sewer [1]
TSS	14,242	9,183	12,227	15,103	9,155	12,389
Total copper	2.96	2.01	2.54	3.14	2.00	2.58
Dissolved copper	0.74	0.59	0.64	0.79	0.59	0.64
Total zinc	18.15	12.14	15.58	19.25	12.10	15.79
Dissolved zinc	5.74	4.17	4.93	6.09	4.15	4.99

Note: TSS = total suspended solids

1. The separated storm and combined sewer stormwater management scenario and the combined sewer stormwater management scenario represent two different proposed stormwater management approaches in the north portal area.

5.4.4 Viaduct Removal

After completion of the new SR 99 bored tunnel, the existing viaduct would be removed. Removal of the existing viaduct is not expected to result in any change in stormwater runoff volumes compared to existing conditions. The area beneath the viaduct is predominantly impervious surface and is expected to produce the same runoff volumes as those generated with the structure in place.

In addition, pollutant loads for the existing viaduct area under the Bored Tunnel Alternative were assumed to be similar to existing conditions. Existing land uses under the viaduct structure include parking and arterial streets. For the purposes of the pollutant load analysis, these land uses were assumed to remain unchanged in the event that the viaduct is removed and were included as pollution-generating surfaces in the calculations.

5.4.5 Battery Street Tunnel Decommissioning

The Battery Street Tunnel would be decommissioned (removed from service) as part of the Bored Tunnel Alternative. One likely decommissioning option would be to partially fill the tunnel with rubble and/or crushed concrete debris from the demolition of the existing viaduct structure. The remainder of the empty space in the tunnel above the crushed concrete would then be injected with controlled-density fill to provide a uniform load support for surface streets.

No changes in surface water runoff volumes or operational effects on surface water quality are expected to result from the filling of the subsurface Battery Street Tunnel. Potential construction effects are discussed in Chapter 6.

5.5 Operational Mitigation

The conventional water quality and peak flow control BMPs proposed for the Bored Tunnel Alternative would address potential risks of adverse effects; therefore, mitigation measures are potentially unnecessary. However, in addition to conventional BMPs, the Seattle Stormwater Code would require the use of green stormwater infrastructure (GSI) practices to the maximum extent feasible for the Bored Tunnel Alternative. GSI is expected to provide additional benefit to surface water in the study area; therefore, this section provides an overview of the proposed GSI elements for the north and south portal areas. These measures are discussed in detail in the *Bored Tunnel Corridor Final Conceptual Hydraulic Report* (CH2M Hill 2010).

GSI measures, which are similar to low-impact development (LID) measures, integrate land use planning and stormwater management practices to reduce the effect of development on the environment. For example, projects using GSI often reduce PGIS by replacing existing PGIS with open spaces. Other GSI elements include the use of infiltration, evapotranspiration, water reuse, and BMPs such as rain gardens, tree box filters, bioretention swales, permeable pavement, reverse slope sidewalks, and other BMPs selected from the Seattle *Stormwater Manual* (Seattle 2009a) or the WSDOT *Highway Runoff Manual* (WSDOT 2008b). Many GSI technologies have the advantage of relatively narrow footprints that would allow them to be either constructed in open space areas or incorporated into the road design to improve the quality of stormwater discharged from the study area.

5.5.1 South Portal Area

In the south portal area, GSI measures are being considered for potential integration into the design of the City Side Trail, a multi-use (pedestrian and bicycle) trail that would be constructed along the eastern side of the south portal area. GSI measures along this area would potentially improve aesthetics while also potentially reducing stormwater runoff through interception, evapotranspiration, and possible infiltration.

The existing soils in the south portal area pose some constraints to GSI measures because they are generally not favorable for infiltration. Also, groundwater in the south portal area is relatively shallow, and contaminated soils are known to exist. These factors may limit the use of the types of GSI facilities that depend on infiltration or require overexcavation, such as infiltration facilities, rain gardens, tree box filters, bioretention swales, and permeable pavement.

5.5.2 North Portal Area

In the north portal area, there would be several opportunities for implementing GSI measures. Bioretention swales and/or stormwater planters could be located within the median and adjacent to the roadway in certain wide pedestrian areas. In addition, under the Bored Tunnel Alternative, free-draining material could be incorporated into the fill that would be required for Aurora Avenue north of Dexter Street. Pervious sidewalks and rain gardens could be placed in the area north of Harrison Street. Vegetated street bulbs with rain gardens could be constructed along portions of Sixth Avenue N. There would also be several areas where tree planters could be incorporated.

The soils in the north portal area range from clayey and silty soils with low infiltration rates to sands and gravels that may have a higher infiltration potential. In addition, areas of perched, shallow groundwater may exist. More detailed investigation would be necessary to evaluate these soils before the implementation of GSI measures.

5.6 Operational Benefits

Both the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative are expected to improve the water quality of runoff being discharged from the project area by reducing the overall amount of PGIS relative to existing conditions (see Exhibit 5-1). In addition, in accordance with the requirements of the Seattle Stormwater Code, peak flow control would be provided in the north portal area, to reduce the frequency and volume of overflows from the combined sewer system, thereby improving water quality by potentially reducing the amount of untreated sewage released to Elliott Bay and Lake Union. Also, basic stormwater quality treatment would be provided for PGIS draining to separated stormwater and low-flow diversion systems.

Chapter 6 CONSTRUCTION EFFECTS AND MITIGATION

6.1 Construction Effects

Construction-related effects of the Bored Tunnel Alternative would be temporary and would be minimized or prevented through proper selection and implementation of BMPs. Construction effects on surface water would generally be the result of construction staging, equipment leaks or spills, material transport, earthwork, paving, stockpiling, storm drainage and/or combined sewer utility work, and dewatering. If not properly controlled through the use of temporary construction BMPs, construction-related pollutants can increase turbidity and affect other water quality parameters, such as the amount of available oxygen in the water. In addition, pH can be increased if runoff comes in contact with curing concrete or bentonite drilling slurry, and this could have serious effects on aquatic species.

Mitigation of the construction effects discussed in this section is presented in Section 6.2. Additional construction effects associated with spoils removal and hazardous materials are discussed in Appendix Q, Hazardous Materials Discipline Report. An overview of the proposed bored tunnel construction and the locations of the staging areas is provided in Appendix B, Alternatives Description and Construction Methods Discipline Report.

6.1.1 Construction Staging

The highest risk of construction-related water quality effects from staging areas comes from erosion of disturbed soil areas or soil stockpiles, which could result in silt and sediment transport to receiving water by stormwater runoff. Fugitive dust could also result in sediment transport if precipitation comes in contact with suspended dust or if runoff occurs in areas where dust has been deposited. Stormwater runoff may also carry other contaminants, such as fuel or oil from construction operations. The highest probability for effects associated with spills of such materials during construction is typically at staging areas. Also, since the staging areas for the Bored Tunnel Alternative are mostly located adjacent to water, there is a greater potential for water quality to be affected by spills during the refueling or servicing of equipment and by stormwater runoff from stockpiled soil or other materials.

6.1.2 Material Transport

Sediment and other contaminants could fall onto roadways and be captured in stormwater runoff along haul routes, i.e., routes over which construction materials and excavation spoils are transported to and from staging areas and between the project construction sites. In addition, because many of the construction materials and excavation spoils may be transferred over water by barge, there is an increased risk of contaminant transport to Elliott Bay during material transfer from the staging areas.

6.1.3 South Portal

Earthwork, Paving, and Stockpiling

Construction in the south portal area would involve a 120-foot open cut just west of First Avenue S., between S. Royal Brougham Way and S. King Street. This portion of the alignment would likely be a cut-and-cover tunnel but may involve ground removal and replacement as well. Excavations would be made for utility relocations, foundation construction, retained cuts, and cut-and-cover tunnels. Construction-related water quality effects would likely be due to erosion of disturbed soil areas or soil stockpiles, resulting in silt and sediment transport to receiving water by stormwater runoff. Fugitive dust could also result in sediment transport if precipitation comes in contact with suspended dust or if runoff occurs in areas where dust has been deposited. In addition, pavement laydown associated with surface street improvements, temporary laydown areas, and parking could also increase the risk of effects from silt and sediment transport and increases in pH if runoff comes in contact with concrete during the curing process.

The south portal area would be the launch location for the tunnel boring machine (TBM). A staging area would be established at the Washington-Oregon Shippers Cooperative Association (WOSCA) site to include facilities needed to support construction in the south portal area, operation of the TBM, and the internal construction of the tunnel. These facilities could include material laydown areas, an electrical power substation, maintenance workshops, construction worker parking, and field offices. In addition, these facilities could include a bentonite slurry separation plant and spoils storage areas to manage the materials generated during operation of the TBM. Exposure to bentonite slurry could increase the pH of surface water or groundwater to approximately 10, which exceeds the state construction general permit benchmark of 8.5 and is toxic to aquatic life.

Stormwater runoff from construction areas may also carry other contaminants, such as fuel or oil from construction equipment. Although the greatest risk for contaminant exposure is typically at dedicated staging areas, some risk would still exist at each construction area. Surface spills from construction equipment or fuel/oil storage tanks that occur near an excavated area could travel through the exposed soil into the groundwater. Further discussion of these effects is included in Appendix Q, Hazardous Materials Discipline Report. Sediment and other contaminants could increase turbidity and affect other water quality parameters, such as the amount of available oxygen in the water.

Storm Drainage and Combined Sewer Utilities

Excavation activities performed in the vicinity of existing storm drainage and/or combined sewer utility pipes increase the risk of an interruption of service if the pipes are inadvertently damaged during construction or relocation.

Because of the tunnel depth, its construction is not expected to disturb utilities except at the tunnel portals. The Bored Tunnel Alternative would require replacement of the majority of the storm drainage and combined sewer utility lines in the south and north portal areas. Detailed information on temporary effects on underground utilities is provided in Appendix K, Public Services and Utilities Discipline Report.

Dewatering

As discussed in Appendix P, Earth Discipline Report, the water table in the south portal area is located about 6 to 10 feet below the ground surface. Therefore, dewatering would be required during construction of the cut-and-cover tunnels and most of the retained cut sections. Preliminary analyses from the design team show that pumping rates along the alignment may range from 100 to 1,000 gallons per minute (approximately 0.2 to 2 cubic feet per second) per 100 feet of open excavation. Dewatering during construction could result in groundwater flow toward the excavated area; therefore subsurface contaminants, including total petroleum hydrocarbons, total suspended solids (TSS), and trace organics, could migrate toward the excavation from areas outside the alignment and increase pollutant concentrations in dewatering water (Parsons Brinckerhoff 2009a). As a result of dewatering, water table drawdown in soils in the vicinity could result in ground settlement, which could damage sensitive structures and facilities. Dewatering would likely continue until the construction of the tunnel retaining wall is completed, which is estimated to take approximately 9 months. Details regarding mitigation measures for dewatering effects are presented in Section 6.2.6.

6.1.4 Bored Tunnel

Earthwork, Paving, and Stockpiling

As previously discussed, the south portal area would be the location for launching the TBM and associated construction support facilities. Associated effects are discussed in Section 6.1.3.

Storm Drainage and Combined Sewer Utilities

Because of the depth of the tunnel, its construction is not expected to disturb storm drainage or combined sewer utility pipes except at the tunnel portals.

Dewatering

Because of the proposed depth of the tunnel, most of the excavation would take place below the groundwater table. The need for dewatering during tunnel boring would depend both on the type of TBM used and on any ground treatments used (Parsons Brinckerhoff 2009a). Specifically, some types of TBMs, such as pressure-face TBMs, can function underwater and do not require dewatering during operation. In addition, ground treatments such as freezing generally eliminate the need for dewatering during the boring process. The type of TBM and ground treatment techniques have not yet been selected for the Bored Tunnel Alternative.

The water quality of dewatering water from the tunnel boring is less of a concern than the quality of dewatering water in the south and north portal areas because groundwater that is removed from deeper soil units is less likely to contain contaminants. However, any water that reaches contaminant thresholds would have to be treated to acceptable standards of the King County Wastewater Discharge Permit or Authorization before being discharged to the combined sewer system, or it would need to be disposed of off-site at an approved hazardous waste facility. Details regarding mitigation measures for dewatering effects are presented in Section 6.2.6.

6.1.5 North Portal

Earthwork, Paving, and Stockpiling

Construction at the north portal would involve a cut-and-cover tunnel from Thomas to Harrison Streets, with the excavation ranging from 30 to 90 feet deep and 70 to 150 feet wide. The transition from the cut-and-cover tunnel to the existing roadway would extend from Harrison to Mercer Streets. Excavations would be made for utility relocations, foundation construction, retained cuts, and cut-and-cover tunnels. Construction-related water quality effects would likely be due to erosion of disturbed soil areas or soil stockpiles, resulting in silt and sediment transport to receiving water by stormwater runoff. Fugitive dust could also result in sediment transport if precipitation comes in contact with suspended dust or if runoff occurs in areas where dust has been deposited. In addition, paving associated with surface street improvements could also increase the risk of effects from silt and sediment transport and/or increases in pH if runoff comes in contact with concrete during the curing process.

Stormwater runoff from construction areas may also carry other contaminants, such as fuel or oil from construction equipment. Although the greatest risk for contaminant exposure is typically at staging areas, some risk would still exist at each construction area. Surface spills from construction equipment or fuel/oil storage tanks that occur near an excavated area could travel through the exposed soil into the groundwater. Further discussion of these effects is included in Appendix Q, Hazardous Materials Discipline Report. Sediment can increase turbidity and affect other water quality parameters, such as the amount of available oxygen in the water. In addition, pH can be increased if runoff comes in contact with concrete during the curing process.

Storm Drainage and Combined Sewer Utilities

Excavation activities performed in the vicinity of existing storm drainage or combined sewer utility pipes would increase the risk of an interruption of service if the pipes are inadvertently damaged during construction or relocation.

Dewatering

As discussed in Appendix P, Earth Discipline Report, the groundwater table in the north portal area is located more than 80 feet below the ground surface; therefore, the need for significant dewatering is not expected. Perched seepage zones that potentially exist above the groundwater table can typically be controlled by sumps and pumps in the excavations.

6.1.6 Viaduct Removal

Earthwork, Paving, and Stockpiling

In addition to the removal of the existing aboveground viaduct structure, it is expected that the columns and footings would be removed to an estimated depth of 5 feet below existing grade. Replacement of the utilities that are buried beneath the viaduct may also be necessary. Some of these relocations or replacements may require excavation. Mitigation measures would be used to ensure that utilities buried beneath the viaduct are not damaged during demolition.

Material stockpiling would be substantial during the dismantling and crushing of the existing viaduct structure. Stormwater exposure to the crushed concrete and associated fugitive dust could result in increased turbidity and pH levels in surface water runoff.

Some localized paving may be required for the restoration of surfaces once the viaduct is removed and after utility replacement or relocation. Such paving activities may result in some minor risk of silt and sediment transport and/or increases in pH if runoff comes in contact with concrete during the curing process.

Storm Drainage and Combined Sewer Utilities

Utilities located on the viaduct and, where necessary, those under the viaduct would be relocated during demolition of the existing structure. Some excavations adjacent to the existing structure would be required for the relocated utilities. The location and depth of the required excavations is not yet determined, but they could be several feet deep. There is a risk of an interruption of service if the storm drainage and/or combined sewer utility pipes being relocated are inadvertently damaged during the process. Coordination with the utility design team would be required to minimize disruptions to utility service during the relocation of existing pipes.

Dewatering

Removal of the viaduct is not expected to require dewatering.

6.1.7 Battery Street Tunnel Decommissioning

Earthwork, Paving, and Stockpiling

Decommissioning the Battery Street Tunnel is not expected to require substantial earthwork. However, there may be some concrete stockpiling during the filling of the tunnel. Stormwater exposure to crushed concrete could result in increases in the turbidity and pH of surface water runoff. In addition, stormwater exposure to the controlled-density fill that might be injected into the tunnel could increase the pH of the associated runoff. Finally, potential paving that may be required to close out the tunnel portals could also slightly increase the risk of silt and sediment transport and/or increases in pH if runoff comes in contact with concrete during the curing process.

Storm Drainage and Combined Sewer Utilities

Existing combined sewer utility pipes are currently located in and around the Battery Street Tunnel. During the filling of the tunnel, there is a risk of an interruption of service if these pipes are inadvertently damaged.

Dewatering

Decommissioning the Battery Street Tunnel is not expected to require dewatering.

6.2 Construction Mitigation

6.2.1 Universal Construction Mitigation Measures

Construction-related runoff and dewatering water would be discharged to the combined sewer system for treatment at the West Point WWTP. The project would need to obtain a wastewater discharge permit or authorization from King County before discharging construction stormwater or dewatering water to the combined sewer. In addition, the construction mitigation measures would need to be reviewed and approved by the City. If the construction-related stormwater and/or dewatering water is discharged to a separated storm drain, the project would potentially need to obtain an NPDES permit from Ecology. Before discharge to either the combined sewer or the separated storm drain, stormwater runoff from active construction areas would need to be treated as necessary to comply with the requirements of the county or state permit. Any dewatering water that reaches contaminant thresholds would have to be treated to acceptable standards of the King County Wastewater Discharge Permit or Authorization before being discharged to the combined sewer system, or it would have to be disposed of off-site at an approved hazardous waste facility. Monitoring should also be performed in accordance with applicable standards.

Construction effects on surface water would be avoided, minimized, and mitigated, and the amount of required treatment would be minimized and mitigated, by the development, implementation, and ongoing updating (based on field conditions) of certain management plans. These plans and their key contents are summarized as follows:

- Construction Stormwater Pollution Prevention Plan: This plan would describe BMPs, including location, size, maintenance requirements, and monitoring; specify methods for handling dewatering water, including storage, treatment, and discharge or disposal; discuss fugitive dust control, including surface protection and wetting techniques; outline flow control, including methods for routing off-site stormwater around the construction area and for controlling on-site stormwater discharges; address detention requirements and protocols to meet requirements and maintain existing conveyance system capacity; describe temporary water quality treatment for on-site stormwater runoff and/or dewatering water, including methods, location, and treatment goals; specify storm drain protection, maintenance, and monitoring; provide a list of Certified Erosion and Sediment Control Leads who would monitor and manage implementation and maintenance of BMPs; and outline water quality monitoring requirements, including location, frequency, and reporting.
- Temporary Erosion and Sediment Control Plan: This plan would outline the design and construction specifications for BMPs to be used to identify, reduce, eliminate, or prevent sediment and erosion problems.
- Spill Prevention, Control, and Countermeasures Plan: This plan would outline requirements for spill prevention, inspection protocols, equipment, material containment measures, and spill response procedures.
- Concrete Containment and Disposal Plan: This plan would outline the management, containment, and disposal of concrete and discuss BMPs that would be used to reduce high pH.

Monitoring would be performed in accordance with applicable standards.

6.2.2 Construction Staging

Effects from construction staging should be mitigated by implementation of the plans discussed in Section 6.2.1.

6.2.3 Material Transport

Effects from the transport of construction material would be mitigated by implementation of the plans discussed in Section 6.2.1. Measures described in these plans should include a requirement that all material handling and transfers be conducted only by trained personnel.

6.2.4 Earthwork, Paving, and Stockpiling

Effects from earthwork, paving, and stockpiling would be mitigated by implementation of the plans discussed in Section 6.2.1.

6.2.5 Storm Drainage and Combined Sewer Utilities

Effects from storm drainage and/or combined sewer utility work would be mitigated by implementation of the plans discussed in Section 6.2.1. In addition, significant coordination between the project's utility design team, affected utility providers, and construction personnel would be required to minimize construction effects during storm drainage and/or combined sewer utility work. Care should be taken to locate existing utilities as accurately as possible before construction activity begins.

6.2.6 Dewatering

Effects from construction dewatering would be mitigated by implementation of the plans discussed in Section 6.2.1. Measures described in these plans should include treatment of water generated by dewatering of shallow groundwater areas before discharge. Groundwater that is 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 adding chemical flocculants (chemicals that promote flocculation by causing colloids and other suspended particles in liquids to clump together into a mass, called a *floc*) to reduce suspended particles before the water is discharged from the project area. Any water that meets contaminant thresholds would have to be treated to acceptable standards of the King County Wastewater Discharge Permit or Authorization before being discharged to the combined sewer system, or it would need to be disposed of off-site at an approved hazardous waste facility.

In addition, 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 discharging dewatering flows to the stormwater or combined sewer system would not be feasible, off-site disposal would be required.

Ground settlement that may result from dewatering would be mitigated with reinjection wells near the excavation area, supplied by water from the dewatering operation. Excess water that is not used for the injection well system would need to be treated and disposed of in the sanitary sewer in accordance with the King County Wastewater Discharge Permit or Authorization (Shannon & Wilson, Inc. 2010). In addition, ground treatment techniques such as freezing may also reduce the need for dewatering. However, adequate site investigation would be necessary to select and design the best ground treatment approaches.

This Page Intentionally Left Blank

Chapter 7 CUMULATIVE EFFECTS

Cumulative effects are effects on the environment that result from the incremental impact of the proposed action when added to other past, present or reasonably foreseeable future actions. The focus of the cumulative effects analysis is the combined effects of the Bored Tunnel Alternative, the other Program elements, and other past, present, and reasonably foreseeable future projects that could contribute to effects on surface water in the study area.

This chapter discusses the following topics:

- Current trends in surface water conditions
- Effects of the roadway elements of the Program
- Effects of the non-roadway elements of the Program
- Cumulative effects of the Bored Tunnel Alternative when combined with the effects of the other Program elements
- Cumulative effects of the Bored Tunnel Alternative when combined with the effects of the other Program elements and the effects of other past, present, and reasonably foreseeable future projects

Attachment B, Cumulative Effects Analysis, provides a more detailed analysis.

7.1 Surface Water Trends

From 1850 through the 1950s, water bodies such as the Puget Sound, Lake Union, and the Duwamish River provided convenient locations for discharging municipal sewage, stormwater runoff, and other industrial wastes. Logging and land clearing resulted in sedimentation in streams, lakes, and marine water bodies. Use of pesticides and fertilizers on landscaped areas and contaminated runoff from impervious surfaces entered surface water via stormwater runoff. A major source of pollution in surface water was untreated road runoff.

These past and ongoing actions have resulted in poor water quality in the project area. Elliott Bay, the Duwamish River, and Lake Union have water quality problems. Elliott Bay exceeds the federal water quality standards for fecal coliform bacteria, lead, and total phosphorus; Elliott Bay and the Duwamish River both exceed the fecal coliform bacteria standard. Current regulations target point discharge sources, and new development or redevelopment is required to control and treat stormwater runoff. These measures along with some movement by the residential and commercial sectors to use natural methods instead of relying on chemicals have resulted in some improvements in water quality. However, water quality problems persist, particularly with regard to water temperature and bacterial contamination. Temperature is significant for the health of fish, especially salmon that need cooler temperatures to survive and spawn. Concentrations of fecal coliform bacteria are significant for human health as an indicator of the presence of disease-carrying organisms. In addition, non-point discharge sources of pollution are not being effectively controlled yet; however, it is expected that small improvements in water quality will occur over time.

The Puget Sound Partnership prepares a periodic report on the State of the Sound, the latest update being for 2009. In that report, trends are reported for various indicators of the health of Puget Sound. The 2009 report lists the following indicators related to surface water as showing a worsening trend: stream flow in major rivers (water quantity indicator) and increases in flame-retardant chemicals (polybrominated diphenyl ethers [PBDEs]) in harbor seals and herring (water quality indicator). Water quality indicators that show improving trends include a decline in PAH concentrations in sediment in Elliott Bay and improvements in freshwater quality. Water quality indicators with no clear trend include hypoxia (depletion of oxygen in water) (Puget Sound Partnership 2010).

7.2 Effects From Other Roadway Elements of the Program

7.2.1 Alaskan Way Surface Street Improvements – S. King to Pike Streets

The Alaskan Way surface street would be six lanes wide between S. King and Columbia Streets (not including turn lanes), transitioning to four lanes between Marion and Pike Streets. Generally the new Alaskan Way surface street would be located on the east side of the right-of-way where the viaduct is located today. The new street would include new sidewalks, bike lanes, parking and loading zones, and signalized pedestrian crossings at cross streets. This improvement is a City of Seattle project, and it will be designed to the City's standards.

This project could result in temporary effects on water quality during construction but would likely improve water quality over the long term through (1) retrofit of currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins, and (2) reduction of peak flows and the frequency of combined sewer overflows by the use of detention facilities to control runoff from combined sewer sub-basins.

7.2.2 Elliott/Western Connector – Pike Street to Battery Street

The new roadway connecting Alaskan Way to Elliott and Western Avenues (in the area between Pike and Battery Streets) would be four lanes wide and would provide a grade-separated crossing of the BNSF mainline railroad tracks. The new roadway would include bicycle and pedestrian facilities. The Lenora Street pedestrian bridge is expected to remain as it is today. Where the bridge terminates on its east side, modifications would be made to provide an at-grade pedestrian crossing on Elliott Avenue.

This project could result in temporary effects on water quality during construction but would likely improve water quality over the long term through (1) retrofit of currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins, and (2) reduction of peak flows and the frequency of combined sewer overflows through the use of detention facilities to control runoff from combined sewer sub-basins.

7.2.3 Mercer West Project – Fifth Avenue to Elliott Avenue

Mercer Street would be restriped and signalized between Fifth Avenue N. and Second Avenue W. to create a two-way street with turn pockets. These improvements also include the restriping and resignalization necessary to convert Roy Street to two-way operations from Fifth Avenue N. to Queen Anne Avenue N.

This project could result in some temporary effects on water quality during construction because of minor disturbances due to traffic light installation. However, if any pavement is replaced, the project could potentially trigger requirements that would improve water quality over the long term. Specifically, if pavement replacement thresholds trigger it, the project might (1) retrofit currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins, and (2) reduce peak flows and the frequency of combined sewer overflows through the use of detention facilities to control runoff from combined sewer sub-basins. Otherwise, the project would likely have little or no effect on long-term water quality.

7.3 Effects From Non-Roadway Elements of the Program

7.3.1 Elliott Bay Seawall Project

The Elliott Bay Seawall needs to be replaced to protect the shoreline along Elliott Bay, including Alaskan Way. It is at risk of failure due to seismic and storm events. The seawall currently extends from S. Washington Street in the south to Bay Street in the north, a distance of about 8,000 feet. The Elliott Bay Seawall Project limits extend from S. Washington Street in the south to Pine Street in the north (also known as the central seawall).

This project has potential for temporary effects on water quality in Elliott Bay during construction because of the necessity for some, but not extensive, in-water work. Careful planning, design, and implementation of construction BMPs would minimize or prevent temporary effects. In the long term, this project would either maintain the existing water quality or could potentially improve it by sealing off contaminated sediments that may be leaching pollutants into Elliott Bay.

7.3.2 Alaskan Way Promenade/Public Space

A new expanded waterfront promenade and public space would be provided to the west of the new Alaskan Way surface street between S. King Street and Pike Street. Between Marion and Pike Streets this space would be approximately 70 to 80 feet wide. This public space will be designed at a later date. Access to the piers would be provided by service driveways. Other potential open space sites include a triangular space north of Pike Street and east of Alaskan Way, and parcels created by the removal of the viaduct between Lenora and Battery Streets.

This project could result in temporary effects on water quality during construction but would likely improve water quality over the long term through (1) conversion of PGIS to non-PGIS or pervious surfaces, and (2) retrofit of currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins. No effects on the combined sewer system are expected in this area because vicinity runoff is collected solely by the separated storm drainage system.

7.3.3 First Avenue Streetcar Evaluation

The First Avenue streetcar is currently planned to run between S. Jackson Street and Republican Street along First Avenue and would include an extension to the South Lake Union streetcar line. The maintenance base would likely be either at the extension of the South Lake Union line or at a new maintenance base that would be built as part of the First Hill streetcar line.

This project could result in temporary effects on water quality during construction but would likely improve water quality over the long term through (1) reduction of traffic volumes and associated pollutant load, (2) retrofit of currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins, and (3) reduction of peak flows and the frequency of combined sewer overflows through the use of detention facilities to control runoff from combined sewer sub-basins.

7.3.4 Transit Enhancements

A variety of transit enhancements would be provided to support planned transportation improvements associated with the Program and to accommodate future demand. These include (1) the Delridge RapidRide line, (2) additional service hours on the West Seattle and Ballard RapidRide lines, (3) peak-hour express routes added to South Lake Union and Uptown, (4) local bus changes (such as realignments and a few additions) to several West Seattle and northwest Seattle routes, (5) transit priority on S. Main and/or S. Washington Streets between Alaskan Way and Third Avenue, and (6) simplification of the electric trolley system. RapidRide transit along the Aurora Avenue corridor would also be provided.

No construction or associated retrofit of currently untreated PGIS would be involved in this project. Therefore, it would not likely have any effects on water quality.

7.4 Cumulative Effects of the Project and Other Program Elements

Over the long term, the entire pending Program would likely improve water quality in Elliott Bay and Lake Union through the following measures:

- Retrofit of currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins.
- Reduction of peak flows and the frequency of combined sewer overflows through the use of detention facilities to control runoff from combined sewer sub-basins.
- Conversion of PGIS to non-PGIS or pervious surfaces.

Temporary effects on water quality would potentially be increased by elements of the Program that are constructed either simultaneously or in immediate sequence. As discussed in Section 6.1, construction effects on surface water would generally be the result of staging, material transport, earthwork, stockpiling, storm drainage and/or combined sewer utility work, and dewatering. Construction-related pollutants can increase turbidity and affect other water quality parameters, such as the amount of available oxygen in the water. In addition, pH can be increased if runoff comes in contact with curing concrete, which could result in serious effects on aquatic species. Implementation of the mitigation measures described in Section 6.2 would minimize or prevent temporary effects.

7.5 Cumulative Effects of the Project, Other Program Elements, and Other Actions

Other past, present, and reasonably foreseeable future actions combined with the Program elements may add to the effects on surface water discussed in this discipline report. The following projects are anticipated in or near the study area:

- Sound Transit projects
- S. Spokane Street Viaduct Widening
- S. Holgate Street to S. King Street Viaduct Replacement Project
- SR 519 Intermodal Access Project, Phase 2
- SR 520 Bridge Replacement and HOV Program
- I-5 Improvements
- South Lake Union Redevelopment
- Mercer East Project
- Washington State Ferries Seattle Terminal Improvements

Similar to the cumulative effects resulting from the Program elements, regional projects anticipated in or near the study area could potentially improve water and sediment quality in Elliott Bay and Lake Union if any of the following measures are included in the projects:

- Retrofit of currently untreated PGIS with, at a minimum, basic water quality treatment BMPs in stormwater sub-basins.
- Reduction of peak flows and the frequency of combined sewer overflows through the use of detention facilities to control runoff from combined sewer sub-basins.
- Conversion of PGIS to non-PGIS or pervious surfaces.
- Removal of contaminated sediments that may be leaching pollutants into Elliott Bay.

Also, as is the case within the Program, temporary effects on water quality would potentially be increased by projects anticipated in or near the study area that are constructed either simultaneously or in immediate sequence. As discussed in Section 6.1, construction effects on surface water would generally be the result of staging, material transport, earthwork, stockpiling, storm drainage and/or combined sewer utility work, and dewatering. Construction-related pollutants can increase turbidity and affect other water quality parameters, such as the amount of available oxygen in the water. In addition, pH can be increased if runoff comes in contact with curing concrete, which could result in serious effects on aquatic species. Implementation of the mitigation measures described in Section 6.2 would minimize or prevent temporary effects.

In addition to the effects described above, the scale of construction and related excavation in the downtown Seattle area that would be required by the Bored Tunnel Alternative could provide an access opportunity for independent third-party projects in the vicinity. For example, the Seattle Combined Sewer System Upgrades project would be an independent third-party project that could potentially save excavation costs by implementing below-grade work concurrent with the excavation of the Bored Tunnel Alternative. This particular project would in turn likely result in a reduction of the frequency of combined sewer overflow events. This project would be developed based on analysis of the entire combined sewer system and may include construction of diversion weirs, detention pipes, conveyance pipes, odor control facilities, and/or pump stations, along with other standard facilities. Any independent, third-party project that would potentially be constructed at the same time as the Alaskan Way Viaduct Replacement Project would be independently analyzed and designed.

Chapter 8 REFERENCES

CH2M Hill. 1999. Denny Way/Lake Union Combined Sewer Overflow, Biological Assessment. Report to King County Department of Natural Resources, Wastewater Treatment Division.

CH2M Hill. 2010. Bored Tunnel Corridor Final Conceptual Hydraulic Report. Prepared by CH2M Hill and submitted to the Washington State Department of Transportation. Seattle, Washington. March 2010.

Ecology (Washington State Department of Ecology). 1994. Elliott Bay Action Program: Environmental Clean-up Activities in Elliott Bay and the Duwamish Waterway. Publication #95-603. Prepared by the Washington State Department of Ecology, Water Quality Program. June 1994.

Ecology. 1995. Elliott Bay Waterfront Recontamination Study Volume 2: Data Evaluation and Remedial Design Recommendations Report. Publication #95-607. Prepared by the Washington State Department of Ecology, Elliott Bay/Duwamish Restoration Panel, Panel Publication 10. August 1995.

Ecology. 2005. Stormwater Management Manual for Western Washington. Publications 99-11 through 99-15. Prepared by the Washington State Department of Ecology, Water Quality Program. February 2005.

Ecology. 2006. Environmental Information Management (EIM) Database. Version 1.0. Available at: http://www.ecy.wa.gov/eim/MyEIM.htm. Washington State Department of Ecology, Sediment Management Unit. February 2006.

Ecology. 2008. Frequently Asked Questions for Sediment Management Standards. Washington State Department of Ecology, Toxics Cleanup Program. Olympia, Washington. June 2008.

Ecology. 2009. 2008 Washington State's Water Quality Assessment [303(d)] Query Tool. Available at: http://www.ecy.wa.gov/programs/wq/303d/2008 /index.html. Last updated February 2009. Accessed September 24, 2009.

EPA (U.S. Environmental Protection Agency). 1988. Elliott Bay Action Program. Analysis of Toxic Problem Area. Final report. Prepared for U.S. Environmental Protection Agency Region X, Office of Puget Sound. July 1988.

FEMA (Federal Emergency Management Agency). 1995a. Flood Insurance Rate Map, King County, Washington and Incorporated Areas. Map Number 53033C0340F. Federal Emergency Management Agency, National Flood Insurance Rate Program. Washington, D.C. May 16, 1995.

FEMA. 1995b. Flood Insurance Rate Map, King County, Washington and Incorporated Areas. Map Number 53033C0630F. Federal Emergency Management Agency, National Flood Insurance Rate Program. Washington, D.C. May 16, 1995.

Hansen, L., T. Georgianna, D. Houck, and J. Frodge. 1994. Lake Union Data Compilation and Review. King County Department of Metropolitan Services. Seattle, Washington.

Hart Crowser. 1994. Sediment Quality Assessment Seattle Ferry Terminal Colman Dock – South Area. Technical memorandum dated October 31, 1994. Seattle, Washington. Report J-4134.

HDR (HDR Engineering, Inc.). 2007. Combined Sewer System Analysis Study. Prepared by HDR Engineering, Inc., Black & Veatch, and Cosmopolitan Engineering Group, Inc.; submitted by Parsons Brinckerhoff to WSDOT. April 2007.

King County. 1994. Draft Data From: Pier 53–55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project Monitoring Program. Prepared for the Elliott Bay/Duwamish Restoration Program Panel. King County Department of Metropolitan Services. November 1993.

King County. 2008. Combined Sewer Overflow Control Program 2007–2008 Annual Report. King County Department of Natural Resources and Parks, Wastewater Treatment Division. October 2008.

King County. 2009a. Surface Water Design Manual. King County Department of Natural Resources and Parks. January 2009.

King County. 2009b. Combined Sewer Overflow Control Program 2008 Annual Report. King County Department of Natural Resources and Parks, Wastewater Treatment Division. July 2009.

King County. 2009c. Combined Sewer Overflow Control, Frequently Asked Questions. Available at: http://www.kingcounty.gov/environment /wastewater/CSO/FAQ.aspx. Last updated on October 22, 2009. Accessed October 22, 2009.

Metro (Municipality of Metropolitan Seattle). 1988a. Final 1988 Combined Sewer Overflow Plan: Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control: An Amendment to Metro's Comprehensive Water Pollution Abatement Plan. Prepared by CWC-HDR Inc. and Ott Water Engineers, Centrac Associates, and Anne C. Symonds and Associates. Seattle, Washington.

Metro. 1988b. Water Quality Status Report for Marine Waters, 1988. Municipality of Metropolitan Seattle.

Metro. 1989. Water Quality Status Report for Marine Waters, 1989. Municipality of Metropolitan Seattle.

Metro. 1993. Pier 53–55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project. Prepared for the Elliott Bay/Duwamish Restoration Program Panel. Municipality of Metropolitan Seattle.

Norton, D. and T. Michelson. 1995. Elliott Bay Waterfront Recontamination Study. Volume 1, Field Investigation Report: Results of Monitoring Conducted Along the Central Seattle Waterfront, October 1993 to October 1994. Prepared for the Elliott Bay/Duwamish Restoration Program Panel. May 1995.

Parsons Brinckerhoff. 2009a. SR 99 Bored Tunnel Alternative – Final staging, Sequencing, Constructibility, and Construction Impacts Study. Seattle, Washington. July 2009.

Puget Sound Partnership. 2010. 2009 State of the Sound. Puget Sound Partnership, Olympia, Washington.

Romberg, P., S.P. Pavlou, R.F. Shokes, W. Hom, E.A. Crecelius, P. Hamilton, J.T. Gunn, and J. Vinelli. 1984. Presence, Distribution, and Fate of Toxicants in Puget Sound and Lake Washington. Toxicant Pretreatment Planning Study: Technical Report C1. Municipality of Metropolitan Seattle.

Rosewater GHD. 2009. SR 99 Bored Tunnel Alternative – Summary Level Stormwater Report. Seattle, Washington. June 2009.

Seattle, City of. 2009a. Stormwater Manual [Directors' Rules for Seattle Municipal Code, Chapters 22.800–22.808 (Stormwater Code)], Volumes 1–4. Seattle Public Utilities, Department of Planning and Development. Publications SPU 2009-003 through 2009-006 and DPD 15-2009 through 18-2009. Seattle, Washington. November 5, 2009.

Seattle, City of. 2009b. Stormwater Code Exception, South King St & Royal Brougham South Basins, South Access Project, Viaduct Replacement Project. Letter from Bruce Bachen, Seattle Public Utilities Drainage and Wastewater Quality Division Director, to Mark W. Anderson, P.E., WSDOT Project Engineer. Seattle, Washington. November 17, 2009.

Shannon & Wilson, Inc. 2010. Dewatering Reinjection Approach Description, email communication with Richard Martin. Shannon & Wilson, Inc. March 8, 2010.

Sillcox, R.L., W.R. Geyer, and G.A. Cannon. 1981. Physical Transport Processes and Circulation in Elliott Bay. NOAA Technical Memorandum. OMPA-8.

Tetra Tech, Inc. 1988. Elliott Bay Action Program: Analysis of Toxic Problem Areas. Prepared for U.S. Environmental Protection Agency by Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, Inc. 2008. CSO Basin Ranking. Technical memorandum from Dennis Eckhardt, Tetra Tech, to Jason Sharpley, Seattle Public Utilities. May 11, 2005.

URS Engineers and Evans-Hamilton. 1986. Elliott Bay Oceanographic Studies, Final Report. Prepared for the Municipality of Metropolitan Seattle.

WSDOT (Washington State Department of Transportation). 2008a. Guidance on Preparing Cumulative Impact Analyses. Washington State Department of Transportation. Olympia, Washington. February 2008.

WSDOT. 2008b. Highway Runoff Manual M 31-16.01. Washington State Department of Transportation, Environmental and Engineering Programs, Design Office. Olympia, Washington. June 2008.

WSDOT. 2009. Quantitative Procedures for Surface Water Impact Assessments. Washington State Department of Transportation. Olympia, Washington. April 13, 2009.

WSDOT. 2010a. Environmental Procedures Manual M 31-11.07. Washington State Department of Transportation, Environmental and Engineering Programs, Environmental Services Office. Olympia, Washington. February 2010.

WSDOT. 2010b. Surface Water Discipline Report Technical Guidance. Washington State Department of Transportation. Olympia, Washington. June 8, 2010.

WSDOT, City of Seattle, and U.S. Department of Transportation, Federal Highway Administration. 2004. SR 99: Alaskan Way Viaduct & Seawall Replacement Project Draft Environmental Impact Statement. Washington State Department of Transportation, Urban Corridors Office, Seattle, Washington.

WSDOT, City of Seattle, and U.S. Department of Transportation, Federal Highway Administration. 2006. SR 99: Alaskan Way Viaduct & Seawall Replacement Project Supplemental Draft Environmental Impact Statement and Section 4(f) Evaluation. Washington State Department of Transportation, Urban Corridors Office, Seattle, Washington.

ATTACHMENT A

Pollutant Loading

This Page Intentionally Left Blank

A.1 POLLUTANT LOADING ANALYSIS

This analysis was conducted to evaluate changes in pollutant load carried by runoff from the surface water study area for the Alaskan Way Viaduct Replacement Project (the project).

A.1.1 Methodology

The approach for analyzing potential operational effects on surface water from the Viaduct Closed (No Build) and Bored Tunnel Alternatives was developed using the Washington State Department of Transportation (WSDOT) Method 1 based on the guidance from the 2010 *Environmental Procedures Manual* (WSDOT 2010) and outlined in the *Quantitative Procedures for Surface Water Impact Assessments* (WSDOT 2009). This method provides a rough quantitative volume-based pollutant loading analysis using the proposed pollutant-generating impervious surface (PGIS) to provide a comparison of project alternatives. Method 1 was developed from the Federal Highway Administration (FHWA) analysis with WSDOT values for pollutant loading from untreated and treated runoff. As shown in Exhibit A-1.1, the pollutants included in Method 1 are total suspended solids, total copper, dissolved copper, total zinc, and dissolved zinc .

Exhibit A-1.1. Annual Pollutant Loads From Untreated and Treated Highway Surfaces

Pollutant	Mean Load From Untreated Surfaces (pounds/acre)	Mean Load From Treated Surfaces (pounds/acre)
TSS	769	88
Total Cu	0.16	0.04
Dissolved Cu	0.04	0.030
Total Zn	0.98	0.21
Dissolved Zn	0.31	0.14

Note: Cu = copper; TSS = total suspended solids; Zn = zinc

Method 1 relies on accurate calculations of study area PGIS and loading factors developed using WSDOT National Pollutant Discharge Elimination System (NPDES) water quality data. Applicable PGIS includes PGIS either created or replaced by a project alternative that is collected in a stormwater drainage system. This method is applicable only to PGIS that is exposed to rainwater. Therefore, pollutant loads were not calculated for areas with pervious surface, non-PGIS, tunnel areas not exposed to rainwater, or PGIS located beneath the existing viaduct in scenarios when it was assumed that the viaduct would still be standing.

The pollutant load estimates for the Viaduct Closed (No Build Alternative) and the Bored Tunnel Alternative were compared to existing conditions to evaluate changes resulting from the project.

A.1.2 Analysis

The existing and proposed pollutant loadings were calculated by multiplying the annual pollutant loading factors (Exhibit A-1.1) by the areas of PGIS. The pollutant loading analysis included the following:

- Existing Conditions: Under existing conditions, it was assumed that all of the existing viaduct and most of the existing north and south portal areas are untreated PGIS. In areas where the existing viaduct is stacked, only the uppermost level of the viaduct was assumed to be exposed to rainwater and was included in the pollutant loading analysis calculations.
- Viaduct Closed (No Build Alternative): Under this alternative, no alternative SR 99 route would be constructed. Progressive deterioration and/or a minor earthquake would leave the existing viaduct structure in place but without the stability to support traffic. Therefore, it was assumed that the existing viaduct would no longer be pollutant-generating. However, it was assumed that the areas in the remainder of the study area (i.e., the south and north portal areas) would be unchanged from the existing conditions.
- Bored Tunnel Alternative: Under the Bored Tunnel Alternative, the overall amount of PGIS would be reduced relative to the existing conditions, specifically due to the proposed design in the south and north portal areas. The existing viaduct would be removed and the remaining surfaces beneath the viaduct were assumed to be PGIS, resulting in a pollutant load for that area similar to existing conditions.

  Under the Bored Tunnel Alternative, basic water quality treatment would be provided for PGIS in the Royal Brougham South sub-basin and Broad sub-basin through application of on-site water quality best management practices (BMPs) selected from the Seattle *Stormwater Manual* (Seattle 2009) and/or the WSDOT *Highway Runoff Manual* (WSDOT 2008). The application of BMPs in these sub-basins was included in the pollutant loading analysis by multiplying the treated annual pollutant loads (see Exhibit A-1.1) by the areas of PGIS.

Treatment of runoff from PGIS located in combined sewer sub-basins was not accounted for in this analysis for existing conditions or either of the project alternatives. Surface water from the project area that discharges to the combined sewer system is mixed with sewage and treated off site at the West Point wastewater treatment plant. Therefore, treatment of this water cannot be accounted for under Method 1 and was not included in the analysis.

Acreages for the existing viaduct drainage sub-basin areas were identified through a review of existing survey data and City of Seattle side sewer cards, as well as field verification. The drainage basin boundaries were mapped in a geographic information system (GIS), and the areas were calculated. Acreages for the existing and proposed drainage sub-basin areas within the south and north portal areas were provided by the design team. Sub-basin area totals for each runoff area are included in the pollutant load results tables in Section A.1.3.

A.1.3 Results

The analysis indicates that the Bored Tunnel Alternative would result in the greatest reduction in pollutant loads compared to the existing conditions and the Viaduct Closed (No Build Alternative). This is largely the result of the overall reduction in PGIS proposed as part of the Bored Tunnel Alternative.

Exhibits A-1.2 through A-1.4 present the individual pollutant load analyses for the south portal area, the viaduct area, and the north portal area, respectively. Exhibit A-1.5 summarizes the pollutant loading for each combination of the south portal and north portal design options and the north portal stormwater management scenarios.

Exhibit A-1.2. Annual Pollutant Loading – South Portal Area

Sub-basin	Land Cover (acres) and Pollutants (pounds/year)	New Dearborn Intersection Design Option			New Dearborn and Charles Intersections Design Option		
		Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative	Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
Royal Brougham South	Pervious	0.02	0.02	0.02	0.02	0.02	0.02
	Non-PGIS	0.09	0.09	0.47	0.09	0.09	0.47
	PGIS	0.65	0.65	0.27	0.65	0.65	0.27
	Total Area	0.76	0.76	0.76	0.76	0.76	0.76
	TSS	500	500	24	500	500	24
	Total Cu	0.10	0.10	0.01	0.10	0.10	0.01
	Dissolved Cu	0.03	0.03	0.01	0.03	0.03	0.01
	Total Zn	0.64	0.64	0.06	0.64	0.64	0.06
	Dissolved Zn	0.20	0.20	0.04	0.20	0.20	0.04
Royal Brougham North	Pervious	0.63	0.63	-	0.63	0.63	-
	Non-PGIS	1.12	1.12	5.53	1.12	1.12	4.39
	PGIS	6.53	6.53	2.89	6.53	6.53	3.57
	Total Area	8.28	8.28	8.42	8.28	8.28	7.96
	TSS	5,022	5,022	2,222	5,022	5,022	2,745
	Total Cu	1.04	1.04	0.46	1.04	1.04	0.57
	Dissolved Cu	0.26	0.26	0.12	0.26	0.26	0.14
	Total Zn	6.40	6.40	2.83	6.40	6.40	3.50
	Dissolved Zn	2.02	2.02	0.90	2.02	2.02	1.11
King	Pervious	0.70	0.70	0.86	0.70	0.70	0.96
	Non-PGIS	0.33	0.33	4.02	0.33	0.33	4.49
	PGIS	9.27	9.27	5.28	9.27	9.27	5.16
	Total Area	10.30	10.30	10.16	10.30	10.30	10.61
	TSS	7,129	7,129	4,060	7,129	7,129	3,968
	Total Cu	1.48	1.48	0.84	1.48	1.48	0.83
	Dissolved Cu	0.37	0.37	0.21	0.37	0.37	0.21
	Total Zn	9.08	9.08	5.17	9.08	9.08	5.06
	Dissolved Zn	2.87	2.87	1.64	2.87	2.87	1.60

Exhibit A-1.2. Annual Pollutant Loading – South Portal Area (continued)

Sub-basin	Land Cover (acres) and Pollutants (pounds/year)	New Dearborn Intersection Design Option			New Dearborn and Charles Intersections Design Option		
		Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative	Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
Total Area	Pervious	1.35	1.35	0.88	1.35	1.35	0.98
	Non-PGIS	1.54	1.54	10.02	1.54	1.54	9.35
	PGIS	16.45	16.45	8.44	16.45	16.45	9.00
	Total Area	19.34	19.34	19.34	19.34	19.34	19.33
	TSS	12,650	12,650	6,306	12,650	12,650	6,737
	Percent Change	-	-	-50%	-	-	-47%
	Total Cu	2.63	2.63	1.32	2.63	2.63	1.41
	Percent Change	-	-	-50%	-	-	-47%
	Dissolved Cu	0.66	0.66	0.33	0.66	0.66	0.36
	Percent Change	-	-	-49%	-	-	-46%
	Total Zn	16.12	16.12	8.06	16.12	16.12	8.61
	Percent Change	-	-	-50%	-	-	-47%
	Dissolved Zn	5.10	5.10	2.57	5.10	5.10	2.74
	Percent Change	-	-	-50%	-	-	-46%

Note: Cu = copper; PGIS = pollutant-generating impervious surface; TSS = total suspended solids; Zn = zinc

Exhibit A-1.3. Annual Pollutant Loading – Viaduct Area

Sub-basin	Land Cover (acres) and Pollutants (pounds/year)	Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
Washington	Pervious	-	-	-
	Non-PGIS	-	1.11	-
	PGIS	1.11	-	1.11
	Total Area	1.11	1.11	1.11
	TSS	851	-	851
	Total Cu	0.18	-	0.18
	Dissolved Cu	0.04	-	0.04
	Total Zn	1.09	-	1.09
	Dissolved Zn	0.34	-	0.34
Madison	Pervious	-	-	-
	Non-PGIS	-	1.18	-
	PGIS	1.18	-	1.18
	Total Area	1.18	1.18	1.18
	TSS	904	-	904
	Total Cu	0.19	-	0.19
	Dissolved Cu	0.05	-	0.05
	Total Zn	1.15	-	1.15
	Dissolved Zn	0.36	-	0.36
Seneca	Pervious	-	-	-
	Non-PGIS	-	0.43	-
	PGIS	0.43	-	0.43
	Total Area	0.43	0.43	0.43
	TSS	329	-	329
	Total Cu	0.07	-	0.07
	Dissolved Cu	0.02	-	0.02
	Total Zn	0.42	-	0.42
	Dissolved Zn	0.13	-	0.13
University	Pervious	-	-	-
	Non-PGIS	-	0.90	-
	PGIS	0.90	-	0.90
	Total Area	0.90	0.90	0.90
	TSS	693	-	693
	Total Cu	0.14	-	0.14
	Dissolved Cu	0.04	-	0.04
	Total Zn	0.88	-	0.88
	Dissolved Zn	0.28	-	0.28

Exhibit A-1.3. Annual Pollutant Loading – Viaduct Area (continued)

Sub-basin	Land Cover (acres) and Pollutants (pounds/year)	Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
Pike	Pervious	-	-	-
	Non-PGIS	-	0.62	-
	PGIS	0.62	-	0.62
	Total Area	0.62	0.62	0.62
	TSS	475	-	475
	Total Cu	0.10	-	0.10
	Dissolved Cu	0.02	-	0.02
	Total Zn	0.61	-	0.61
	Dissolved Zn	0.19	-	0.19
Pine	Pervious	-	-	-
	Non-PGIS	-	1.99	-
	PGIS	1.99	-	1.99
	Total Area	1.99	1.99	1.99
	TSS	1,534	-	1,534
	Total Cu	0.32	-	0.32
	Dissolved Cu	0.08	-	0.08
	Total Zn	1.95	-	1.95
	Dissolved Zn	0.62	-	0.62
Vine	Pervious	-	-	-
	Non-PGIS	-	2.16	-
	PGIS	2.16	-	2.16
	Total Area	2.16	2.16	2.16
	TSS	1,658	-	1,658
	Total Cu	0.34	-	0.34
	Dissolved Cu	0.09	-	0.09
	Total Zn	2.11	-	2.11
	Dissolved Zn	0.67	-	0.67

Exhibit A-1.3. Annual Pollutant Loading – Viaduct Area (continued)

Sub-basin	Land Cover (acres) and Pollutants (pounds/year)	Existing Conditions	Viaduct Closed (No Build Alternative)	Bored Tunnel Alternative
Total Area	Pervious	-	-	-
	Non-PGIS	-	8.38	-
	PGIS	8.38	-	8.38
	Total Area	8.38	8.38	8.38
	TSS	6,443	-	6,443
	Percent Change	-	-100%	-
	Total Cu	1.34	-	1.34
	Percent Change	-	-100%	-
	Dissolved Cu	0.34	-	0.34
	Percent Change	-	-100%	-
	Total Zn	8.21	-	8.21
	Percent Change	-	-100%	-
	Dissolved Zn	2.60	-	2.60
	Percent Change	-	-100%	-

Note: Cu = copper; PGIS = pollutant-generating impervious surface; TSS = total suspended solids; Zn = zinc.

Exhibit A-1.4. Annual Pollutant Loading – North Portal Area

Sub-basin	Land Cover (acres) and Pollutants (pounds/year])	Curved Sixth Avenue Design Option				Straight Sixth Avenue Design Option			
		Existing Conditions	Viaduct Closed (No Build Alternative)	Separated Storm and Combined Sewer [1]	Combined Sewer [1]	Existing Conditions	Viaduct Closed (No Build Alternative)	Separated Storm and Combined Sewer [1]	Combined Sewer [1]
Broad	Pervious	0.47	0.47	-	-	0.47	0.47	-	-
Broad	Non-PGIS	0.63	0.63	1.37	-	0.63	0.63	1.55	-
Broad	PGIS	3.76	3.76	4.47	-	3.76	3.76	4.41	-
Broad	Total Area	4.86	4.86	5.84	-	4.86	4.86	5.96	-
Broad	TSS	2,891	2,891	393	-	2,891	2,891	388	-
Broad	Total Cu	0.60	0.60	0.18	-	0.60	0.60	0.18	-
Broad	Dissolved Cu	0.15	0.15	0.13	-	0.15	0.15	0.13	-
Broad	Total Zn	3.68	3.68	0.94	-	3.68	3.68	0.93	-
Broad	Dissolved Zn	1.17	1.17	0.63	-	1.17	1.17	0.62	-
Dexter	Pervious	1.20	1.20	0.89	0.89	1.20	1.20	0.84	0.84
Dexter	Non-PGIS	4.25	4.25	6.91	8.28	4.81	4.81	8.58	9.83
Dexter	PGIS	14.76	14.76	11.43	15.90	15.88	15.88	11.40	16.11
Dexter	Total Area	20.21	20.21	19.23	25.07	21.89	21.89	20.82	26.78
Dexter	TSS	11,350	11,350	8,790	12,227	12,212	12,212	8,767	12,389
Dexter	Total Cu	2.36	2.36	1.83	2.54	2.54	2.54	1.82	2.58
Dexter	Dissolved Cu	0.59	0.59	0.46	0.64	0.64	0.64	0.46	0.64
Dexter	Total Zn	14.46	14.46	11.20	15.58	15.56	15.56	11.17	15.79
Dexter	Dissolved Zn	4.58	4.58	3.54	4.93	4.92	4.92	3.53	4.99

Exhibit A-1.4. Annual Pollutant Loading – North Portal Area (continued)

Sub-basin	Land Cover (acres) and Pollutants (pounds/year)	Curved Sixth Avenue Design Option				Straight Sixth Avenue Design Option			
		Existing Conditions	Viaduct Closed (No Build Alternative)	Separated Storm and Combined Sewer [1]	Combined Sewer [1]	Existing Conditions	Viaduct Closed (No Build Alternative)	Separated Storm and Combined Sewer [1]	Combined Sewer [1]
Total Area	Pervious	1.67	1.67	0.89	0.89	1.67	1.67	0.84	0.84
	Non-PGIS	4.88	4.88	8.28	8.28	5.44	5.44	10.13	9.83
	PGIS	18.52	18.52	15.90	15.90	19.64	19.64	15.81	16.11
	Total Area	25.07	25.07	25.07	25.07	26.75	26.75	26.78	26.78
	TSS	14,242	14,242	9,183	12,227	15,103	15,103	9,155	12,389
	Percent Change	-	-	-36%	-14%	-	-	-39%	-18%
	Total Cu	2.96	2.96	2.01	2.54	3.14	3.14	2.00	2.58
	Percent Change	-	-	-32%	-14%	-	-	-36%	-18%
	Dissolved Cu	0.74	0.74	0.59	0.64	0.79	0.79	0.59	0.64
	Percent Change	-	-	-20%	-14%	-	-	-25%	-18%
	Total Zn	18.15	18.15	12.14	15.58	19.25	19.25	12.10	15.79
	Percent Change	-	-	-33%	-14%	-	-	-37%	-18%
	Dissolved Zn	5.74	5.74	4.17	4.93	6.09	6.09	4.15	4.99
	Percent Change	-	-	-27%	-14%	-	-	-32%	-18%

Note: Cu = copper; PGIS = pollutant-generating impervious surface; TSS = total suspended solids; Zn = zinc

1. The Separated Storm and Combined Sewer stormwater management scenario and the Combined Sewer stormwater management scenario represent two different proposed stormwater management approaches in the north portal area.

Exhibit A-1.5. Annual Pollutant Loading Summary – Bored Tunnel Alternative

Land Cover (acres) and Pollutants (pounds/year)	Existing Conditions	Viaduct Closed (No Build Alternative)	Separated Storm and Combined Sewer [1]	Combined Sewer [1]
New Dearborn Intersection and Curved Sixth Avenue Design Options				
Pervious	3.02	3.02	1.77	1.77
Non-PGIS	6.42	14.80	18.30	18.30
PGIS	43.35	34.97	32.72	32.72
Total Area	52.79	52.79	52.79	52.79
TSS	33,335	26,892	21,933	24,977
Percent Change	-	-19%	-34%	-25%
Total Cu	6.94	5.60	4.67	5.20
Percent Change	-	-19%	-33%	-25%
Dissolved Cu	1.73	1.40	1.26	1.31
Percent Change	-	-19%	-27%	-25%
Total Zn	42.48	34.27	28.41	31.86
Percent Change	-	-19%	-33%	-25%
Dissolved Zn	13.44	10.84	9.34	10.10
Percent Change	-	-19%	-31%	-25%
New Dearborn Intersection and Straight Sixth Avenue Design Options				
Pervious	3.02	3.02	1.72	1.72
Non-PGIS	6.98	15.36	20.15	19.85
PGIS	44.47	36.09	32.63	32.93
Total Area	54.47	54.47	54.50	54.50
TSS	34,197	27,753	21,905	25,139
Percent Change	-	-19%	-36%	-26%
Total Cu	7.12	5.77	4.66	5.24
Percent Change	-	-19%	-35%	-26%
Dissolved Cu	1.78	1.44	1.26	1.31
Percent Change	-	-19%	-29%	-26%
Total Zn	43.58	35.37	28.37	32.06
Percent Change	-	-19%	-35%	-26%
Dissolved Zn	13.79	11.19	9.32	10.16
Percent Change	-	-19%	-32%	-26%
New Dearborn and Charles Intersections and Curved Sixth Avenue Design Options				
Pervious	3.02	3.02	1.87	1.87
Non-PGIS	6.42	14.80	17.63	17.63
PGIS	43.35	34.97	33.28	33.28
Total Area	52.79	52.79	52.78	52.78

Exhibit A-1.5. Annual Pollutant Loading Summary – Bored Tunnel Alternative (continued)

Land Cover (acres) and Pollutants (pounds/year)	Existing Conditions	Viaduct Closed (No Build Alternative)	Separated Storm and Combined Sewer [1]	Combined Sewer [1]
TSS	33,335	26,892	22,364	25,408
Percent Change	-	-19%	-33%	-24%
Total Cu	6.94	5.60	4.76	5.29
Percent Change	-	-19%	-31%	-24%
Dissolved Cu	1.73	1.40	1.28	1.33
Percent Change	-	-19%	-26%	-23%
Total Zn	42.48	34.27	28.96	32.41
Percent Change	-	-19%	-32%	-24%
Dissolved Zn	13.44	10.84	9.51	10.27
Percent Change	-	-19%	-29%	-24%
New Dearborn and Charles Intersections and Straight Sixth Avenue Design Options				
Pervious	3.02	3.02	1.82	1.82
Non-PGIS	6.98	15.36	19.48	19.18
PGIS	44.47	36.09	33.19	33.49
Total Area	54.47	54.47	54.49	54.49
TSS	34,197	27,753	22,335	25,569
Percent Change	-	-19%	-35%	-25%
Total Cu	7.12	5.77	4.75	5.33
Percent Change	-	-19%	-33%	-25%
Dissolved Cu	1.78	1.44	1.28	1.34
Percent Change	-	-19%	-28%	-25%
Total Zn	43.58	35.37	28.92	32.61
Percent Change	-	-19%	-34%	-25%
Dissolved Zn	13.79	11.19	9.49	10.34
Percent Change	-	-19%	-31%	-25%

Note: Cu = copper; PGIS = pollutant-generating impervious surface; TSS = total suspended solids; Zn = zinc.

1. The Separated Storm and Combined Sewer stormwater management scenario and the Combined Sewer stormwater management scenario represent two different proposed stormwater management approaches in the north portal area.

A.2 REFERENCES

Seattle, City of. 2009. Stormwater Manual [Directors' Rules for Seattle Municipal Code, Chapters 22.800–22.808 (Stormwater Code)], Volumes 1–4. Seattle Public Utilities, Department of Planning and Development. Publications SPU 2009-003 through 2009-006 and DPD 15-2009 through 18-2009. Seattle, Washington. November 5, 2009.

WSDOT (Washington State Department of Transportation). 2008. Highway Runoff Manual. M 31-16.01. Washington State Department of Transportation, Environmental and Engineering Programs, Design Office. Olympia, Washington. June 2008.

WSDOT. 2009. Quantitative Procedures for Surface Water Impact Assessments. Washington State Department of Transportation. Olympia, Washington. April 13, 2009.

WSDOT. 2010. Environmental Procedures Manual. M 31-11.07. Washington State Department of Transportation, Environmental and Engineering Programs, Environmental Services Office. Olympia, Washington. February 2010.

This Page Intentionally Left Blank

ATTACHMENT B

Cumulative Effects Analysis

This Page Intentionally Left Blank

CUMULATIVE EFFECTS ANALYSIS

This cumulative effects analysis follows *Guidance on Preparing Cumulative Impact Analyses*, published by Washington State Department of Transportation (WSDOT) in February 2008. The guidance document was developed jointly by WSDOT, Federal Highway Administration (FHWA) – Washington Division, and U.S. Environmental Protection Agency – Region 10. The guidance can be used for FHWA's National Environmental Policy Act (NEPA) compliance (Code of Federal Regulations, Title 23, Part 771) and fulfillment of Washington State Environmental Policy Act (SEPA) requirements for evaluation of cumulative effects (Washington Administrative Code, Section 197-11-792).

The approach provided in the WSDOT guidance calls for early consideration of cumulative impacts while direct and indirect effects are being identified, preferably as part of the scoping process. For analysis, the guidance recommends the use of environmental documents such as discipline reports, as well as other relevant information such as local comprehensive plans, zoning, recent building permits, and interviews with local government. The guidance also advocates a partnership approach among agencies that includes early collaboration and integrated planning activities.

The guidance established eight steps to serve as guidelines for identifying and assessing cumulative impacts. These eight steps have been used in the following cumulative effects evaluation for the Bored Tunnel Alternative of the Alaskan Way Viaduct Replacement Project (the project). A matrix that identifies projects with the potential for cumulative effects with this project and an assessment of likely contributions to cumulative effects is also included.

<u>Step 1</u>. Identify the resource that may have cumulative impacts to consider in the analysis

Surface water

<u>Step 2</u>. Define the study area and timeframe for the affected resource

The study area comprises Elliott Bay, Lake Union, central Puget Sound, and associated surface water draining to these resources from the Seattle metropolitan area.

The analysis timeframe for surface water begins in 1850, which is recognized as the start of significant European settlement in the Puget Sound region. The existing conditions for the affected environment are analyzed for the period just before construction of the project would begin in 2011. The timeframe for construction-related (temporary) impacts is the approximately 5.5-year construction duration for the Bored Tunnel Alternative (2011 through 2017). The timeframe for operational impacts is from the year of opening (2015) to the design year of the project (2030).

<u>Step 3</u>. Describe the current health and historical context for the affected resource

Puget Sound is a large marine water body that covers approximately 900 square miles, including Elliott Bay. Lake Union represents a transitional area between the fresh waters of Lake Washington and the marine waters of Puget Sound. These bodies of water, along with the drainage associated with them, have poor water quality due to activities such as agriculture, road construction, fertilizers, marine activities, and urban development, which occurred over the past 150 years.

Elliott Bay has been designated for protection by the Washington State Department of Ecology (Ecology) for excellent aquatic life habitat, shellfish harvest, primary contact recreation, wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics. Ecology has designated Lake Union for protection for core summer habitat, excellent primary contact recreational uses, water supply (domestic, industrial, agricultural, and stock), wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics.

Elliott Bay is listed on the Ecology's 303(d) water quality list for exceeding the criteria for fecal coliform bacteria. Other than Elliott Bay, no areas of Puget Sound in the vicinity of the proposed project have been listed on Ecology's 303(d) water quality list. Lake Union is listed on Ecology's 303(d) water quality list for exceeding the criteria for aldrin, fecal coliform bacteria, lead, and total phosphorus. Sediments within central Puget Sound, Elliott Bay, and Lake Union have also exceeded numerous Washington State quality criteria.

In the downtown Seattle area, land surfaces generating runoff that drains to Elliott Bay, Lake Union, and central Puget Sound have been developed for over 100 years and are assumed to be effectively impervious. Stormwater from the project area is collected either in separated storm drainage pipes or in the combined sewer system. Stormwater drainage sub-basins discharge untreated runoff to Elliott Bay and Lake Union, whereas stormwater that drains to the combined sewer system is generally treated at the West Point Wastewater Treatment Plant and discharged to Puget Sound. When flows exceed the capacity of the combined sewer system, typically during heavy rain events, flows are diverted to backup wet-weather treatment facilities or discharged as untreated diluted wastewater directly to Elliott Bay and Lake Union.

Step 4. Identify the direct and indirect impacts that may contribute to a cumulative impact

The stormwater management approach for the Bored Tunnel Alternative would maintain existing drainage patterns and generally direct surface area runoff to the combined sewer system for water quality treatment. One exception to this approach is the south end of the project area. Because runoff from this small area is not currently discharged exclusively to the combined sewer system, basic water quality treatment would be provided for this area by applying water quality best management practices (BMPs) selected from the WSDOT *Highway Runoff Manual*.

For the remaining portions of the project area that discharge to the combined sewer system, if future modeling shows that detention of runoff from the project area would reduce the risk of overflows from the combined sewer system to Elliott Bay and Lake Union, the project would comply with this requirement either through installation of detention facilities or through some form of alternative compliance (e.g., payment of a fee-in-lieu of detention or development and implementation of an integrated drainage plan). In addition, the Bored Tunnel Alternative is expected to reduce the overall amount of pollutant-generating impervious surface (PGIS) relative to the amount under existing conditions, which would potentially reduce the total pollutant load carried to the combined sewer system.

Overall, the Bored Tunnel Alternative is expected to either maintain or improve the quality of stormwater that is discharged from the project area to central Puget Sound, Elliott Bay, and Lake Union.

Step 5. Identify other historic, current, or reasonably foreseeable actions that may affect resources

The project team considered 39 projects (shown in the cumulative effects matrix at the end of this attachment) for potential activities that could have a cumulative effect on Elliott Bay and central Puget Sound. The following 25 projects were identified as having between no cumulative effect and a moderately beneficial cumulative effect by potentially improving the quality of surface water runoff:

- **A1.** Alaskan Way Surface Street Improvements – S. King Street to Pike Street
- **A2.** Elliott/Western Connector – Pike Street to Battery Street
- **A3.** Mercer West Project – Mercer Street becomes two-way from Fifth Avenue N. to Elliott Avenue, and Roy Street becomes two-way from Aurora Avenue to Queen Anne Avenue N.
- **B2.** Alaskan Way Promenade/Public Space
- **B4.** First Avenue Streetcar Evaluation
- **C1.** S. Holgate Street to S. King Street Viaduct Replacement Project
- **E3.** Seattle Center Master Plan (EIS) (Century 21 Master Plan)
- **E5.** South Lake Union Redevelopment
- **E6.** U.S. Coast Guard Integrated Support Command
- **E7.** Seattle Aquarium and Waterfront Park
- **E8.** Seattle Combined Sewer System Upgrades
- **F1.** Bridging the Gap Projects
- **F2.** S. Spokane Street Viaduct Widening
- **F3.** SR 99/East Marginal Way Grade Separation
- **F4.** Mercer East Project from Dexter Avenue N. to I-5
- **G1.** I-5 Improvements
- **G2.** SR 520 Bridge Replacement and HOV Program
- **H1.** First Hill Streetcar
- **H2.** Sound Transit University Link Light Rail Project

- **H4.** Sound Transit North Link Light Rail
- **H5.** Sound Transit East Link Light Rail
- **H6.** Washington State Ferries Seattle Terminal Improvements
- **I2.** Sound Transit Phases 1 and 2
- **J1.** Sound Transit Central Link Light Rail (including the Sea-Tac Airport extension)
- **J3.** SR 519 Intermodal Access Project, Phase 2

The following two projects were identified as potentially having a somewhat negative cumulative effect by establishing new housing, thereby increasing the demand on the combined sewer system and in turn increasing the risk of combined sewer overflows directly to Elliott Bay or indirectly through Lake Union:

- **E2.** North Parking Lot Development at Qwest Field
- **E5.** South Lake Union Redevelopment

Step 6. Assess potential cumulative impacts to the resource; determine the magnitude and significance

The net cumulative effect from the identified projects is expected to be moderately beneficial to the water quality in Elliott Bay. The projects have the potential for a temporary negative effect on water quality during construction, but it would be mitigated with appropriate BMPs. In addition, some projects have the potential to increase the risk of combined sewer overflow events. However, combined, these projects would potentially result in a net improvement to water quality released to Elliott Bay over the long term by (1) retrofitting currently untreated PGIS with water quality BMPs in stormwater sub-basins, and (2) reducing peak flows and the potential for combined sewer overflows through the use of detention in combined sewer sub-basins. Also, these projects would mitigate most effects of any new pollutant-generating surfaces with appropriate BMPs.

Step 7. Report the results

As previously discussed, the net effect on water quality in Elliott Bay is expected to be moderately beneficial. Cumulatively, this effect is expected to be only moderately beneficial because the stormwater and combined sewer discharges to Elliott Bay and central Puget Sound from the listed projects contribute only a small portion of the water that enters these resources.

Step 8. Assess and discuss potential mitigation issues for all adverse impacts

The net cumulative effect on surface water resources from the historical, current, and reasonably foreseeable actions that have been discussed is expected to be beneficial. However, one type of potential negative effect has been identified; some projects have the potential to increase the risk of combined sewer overflow events by increasing waste supply. This risk could be offset by capacity improvements to the City of Seattle combined sewer system, such as those proposed in project E8, Seattle Combined Sewer System Upgrades. Additionally, the risk of combined sewer overflow events would be reduced by the implementation of required localized, on-site detention of surface water by other projects, which would result in decreased demand on the combined sewer system.

The following matrix identifies project-specific cumulative effects.

PROJECT-SPECIFIC CUMULATIVE EFFECTS MATRIX

PROJECT	POTENTIAL CUMULATIVE EFFECTS
A. Roadway Elements	
A1. Alaskan Way Surface Street Improvements – S. King Street to Pike Street	Cumulative long-term effects are expected to be between no effect and moderately beneficial effects. The project would potentially improve water quality over the long term if thresholds are triggered requiring (1) retrofit of currently untreated PGIS with water quality BMPs in stormwater sub-basins, and (2) reduction of peak flows and the potential for untreated combined sewer overflows through the use of detention in combined sewer sub-basins. At minimum, this project would maintain existing water quality of the runoff within its boundary by maintaining the current quality of runoff in existing areas and treating runoff from any new pollutant-generating surfaces with appropriate BMPs.
A2. Elliott/Western Connector – Pike Street to Battery Street	Effects expected to be similar to those described for project A1.
A3. Mercer West Project – Mercer Street becomes two-way from Fifth Avenue N. to Elliott Avenue, and Roy Street becomes two-way from Aurora Avenue to Queen Anne Avenue N.	Effects expected to be similar to those described for project A1.
B. Non-Roadway Elements	
B1. Elliott Bay Seawall Project	Little to no cumulative effect. This project would potentially have some short-term construction effects, but long-term effects on surface water quality are not expected.
B2. Alaskan Way Promenade/Public Space	Effects expected to be similar to those described for project A1.
B3. Transit Enhancements – 1) Delridge RapidRide 2) Additional service hours on West Seattle and Ballard RapidRide lines 3) Peak hour express routes added to South Lake Union and Uptown 4) Local bus changes to several West Seattle and northwest Seattle routes 5) Transit priority on S. Main and/or S. Washington Streets between Alaskan Way and Third Avenue 6) Simplification of the electric trolley system	No long-term cumulative effects on surface water quality are expected. Negative effects are not expected because the project is not expected to add and/or replace any pollutant-generating surfaces. Beneficial effects are not expected because the project would not likely trigger any requirements to apply water quality or detention BMPs.
B4. First Avenue Streetcar Evaluation	Effects expected to be similar to those described for project A1.

PROJECT-SPECIFIC CUMULATIVE EFFECTS MATRIX (CONTINUED)

PROJECT	POTENTIAL CUMULATIVE EFFECTS
C. Projects Under Construction	
C1. S. Holgate Street to S. King Street Viaduct Replacement Project	Effects expected to be similar to those described for project A1.
C2. Transportation Improvements to Minimize Traffic Effects During Construction	Effects expected to be similar to those described for project B3.
D. Completed Projects	
D1. SR 99 Yesler Way Vicinity Foundation Stabilization (Column Safety Repairs)	Effects expected to be similar to those described for project B3.
D2. S. Massachusetts Street to Railroad Way S. Electrical Line Relocation Project (Electrical Line Relocation Along the Viaduct's South End)	Effects expected to be similar to those described for project B3.
E. Seattle Planned Urban Development	
E1. Gull Industries on First Avenue S.	Effects expected to be similar to those described for project B3.
E2. North Parking Lot Development at Qwest Field	No effects on the quality of surface water runoff are expected from this project because (1) no addition and/or replacement of pollutant-generating surfaces is expected, and (2) the project would not likely trigger any requirements to apply surface water quality or detention BMPs. However, the project may potentially have a moderately negative effect on the quality of water discharged to Elliott Bay. Specifically, by establishing new housing, the project would increase the demand on the combined sewer system and thereby increase the risk of combined sewer overflows.
E3. Seattle Center Master Plan (EIS) (Century 21 Master Plan)	Effects expected to be similar to those described for project A1.
E4. Bill and Melinda Gates Foundation Campus Master Plan	Effects expected to be similar to those described for project B3.
E5. South Lake Union Redevelopment	Determination of net effects from this project would require more detailed evaluation. This project could have temporary negative water quality effects during construction that would be mitigated with appropriate BMPs. The project would potentially improve water quality of surface water runoff over the long term if thresholds are triggered requiring (1) retrofit of currently untreated PGIS with water quality BMPs in stormwater sub-basins, and (2) reduction of peak flows and the potential for untreated combined sewer overflows through the use of detention in combined sewer sub-basins. However, by establishing new housing, the project would increase the demand on the combined sewer system and thereby increase the risk of combined sewer overflows to Elliott Bay, either directly or indirectly through Lake Union.
E6. U.S. Coast Guard Integrated Support Command	Based on the information available for this project at the time of this report, it is unknown whether any cumulative effects should be expected. If any do occur, they would most likely be similar to those described for project A1.
E7. Seattle Aquarium and Waterfront Park	Effects for the remainder of the project area would be similar to those described for project B3.

PROJECT-SPECIFIC CUMULATIVE EFFECTS MATRIX (CONTINUED)

PROJECT	POTENTIAL CUMULATIVE EFFECTS
E8. Seattle Combined Sewer System Upgrades	This project would likely result in a moderately beneficial cumulative effect on water quality. It would provide protection against combined sewer overflows in addition to the protection that would already be provided by other projects through localized, on-site detention.
F. Local Roadway Improvements	
F1. Bridging the Gap Projects	Effects expected to be similar to those described for project A1.
F2. S. Spokane Street Viaduct Widening	Effects expected to be similar to those described for project A1.
F3. SR 99/East Marginal Way Grade Separation	Effects expected to be similar to those described for project A1.
F4. Mercer East Project from Dexter Avenue N. to I-5	Effects expected to be similar to those described for project A1.
G. Regional Roadway Improvements	
G1. I-5 Improvements	Effects expected to be similar to those described for project A1.
G2. SR 520 Bridge Replacement and HOV Program	Cumulative long-term effects are expected to be beneficial. The program would likely improve water quality over the long term through retrofit of currently untreated PGIS with water quality BMPs in stormwater sub-basins, and (where applicable) reduction of peak flows and the potential for untreated combined sewer overflows through the use of detention in combined sewer sub-basins.
G3. I-405 Corridor Program	No cumulative long-term effects are expected. In the long term, the program would potentially mitigate any expected negative effects from new pollutant-generating surfaces through the use of appropriate BMPs.
G4. I-90 Two-Way Transit and HOV Operations Stages 1 and 2	Effects expected to be similar to those described for project G3.
H. Transit Improvements	
H1. First Hill Streetcar	Effects expected to be similar to those described for project A1.
H2. Sound Transit University Link Light Rail Project	Effects expected to be similar to those described for project A1.
H3. RapidRide	Effects expected to be similar to those described for project B3.
H4. Sound Transit North Link Light Rail	Effects expected to be similar to those described for project A1.
H5. Sound Transit East Link Light Rail	Effects expected to be similar to those described for project A1.
H6. Washington State Ferries Seattle Terminal Improvements	Effects expected to be similar to those described for project A1.
I. Transportation Network Assumptions	
I1. HOV Definition Changes to 3+ Throughout the Puget Sound Region	Effects expected to be similar to those described for project B3.
I2. Sound Transit Phases 1 and 2	Effects expected to be similar to those described for project A1.
I3. Other Transit Improvements	Effects expected to be similar to those described for project B3.

PROJECT-SPECIFIC CUMULATIVE EFFECTS MATRIX (CONTINUED)

PROJECT	POTENTIAL CUMULATIVE EFFECTS
J. Completed but Relevant Projects	
J1. Sound Transit Central Link Light Rail (including the Sea-Tac Airport extension)	Effects expected to be similar to those described for project A1.
J2. South Lake Union Streetcar	Effects expected to be similar to those described for project A1.
J3. SR 519 Intermodal Access Project, Phase 2	Effects expected to be similar to those described for project A1.