

Ship Canal Water Quality Project

Final Facility Plan

March 2017



Ship Canal Water Quality Project

Final Facility Plan

March 2017

Prepared for:

Seattle Public Utilities
Seattle Municipal Tower, Suite 4900
700 Fifth Avenue
Seattle, Washington 98124-4018

This document has been prepared under the direction of a registered professional engineer.



Court V. Harris, PE #36492
CH2M
Responsible Engineer

Prepared by:

CH2M
Abeyta & Associates
Aqua Terra Cultural Resources Consultants
Environmental Science Associates, Inc. (ESA)
Gladstone Enterprises, LLC
The Greenbusch Group, Inc.
Heffron Transportation
Lindsey Amtmann, LLC
Seattle Public Utilities
Shannon & Wilson
UrbanTech Systems, Inc.

This page intentionally left blank.

Contents

Facility Plan Acronyms.....	xv
Section 1 Executive Summary.....	1-1
1.1 Background	1-1
1.2 Regulatory Requirements.....	1-2
1.3 Combined Sewer Overflow Control Options Development and Evaluation	1-3
1.4 Recommended Option	1-5
Section 2 Contact Information.....	2-1
Section 3 Facility Plan Overview and Background	3-1
3.1 Document Organization.....	3-1
3.2 Problem Identification.....	3-3
3.3 Combined Sewer Overflow Control and Storage Volume	3-4
3.4 Sewer Classifications and Related Combined Sewer Overflow Impacts.....	3-6
3.4.1 Combined Sewer System	3-6
3.4.2 Separated Sewer Systems	3-6
3.4.3 Partially Separated Sewer Systems	3-6
3.5 Regional Combined Sewer Overflow Reduction Efforts	3-7
3.6 Regulatory Framework	3-11
3.6.1 Clean Water Act and National Pollutant Discharge Elimination System Permits.....	3-11
3.6.2 U.S. Environmental Protection Agency Combined Sewer Overflow Control Policy of 1994.....	3-11
3.6.3 Washington State Law, National Pollutant Discharge Elimination System Permits, and Consent Decrees.....	3-12
Section 4 Existing Environment.....	4-1
4.1 Earth and Groundwater	4-1
4.1.1 Earth.....	4-1
4.1.2 Groundwater	4-2
4.1.3 Contamination	4-2
4.2 Surface Water	4-3
4.2.1 Ship Canal.....	4-3
4.2.2 Lake Union	4-4
4.2.3 Floodplains.....	4-4

4.3	Air Quality and Odors	4-4
4.3.1	General Air Quality Conditions	4-4
4.3.2	Odor Conditions	4-5
4.4	Fisheries and Biological Resources	4-5
4.4.1	Ship Canal.....	4-6
4.4.2	Terrestrial Habitats and Wetlands.....	4-7
4.5	Land and Shoreline Use and Visual Quality	4-7
4.5.1	Land and Shoreline Use.....	4-7
4.5.2	Visual Quality	4-8
4.6	Recreation	4-9
4.6.1	Ship Canal.....	4-9
4.6.2	Hiram M. Chittenden Locks	4-9
4.6.3	Ship Canal Trail.....	4-10
4.6.4	Seattle Pacific University Athletic Fields and Facilities	4-10
4.6.5	West Ewing Mini Park	4-10
4.6.6	Shilshole Avenue NW and Other Streets in the Project Area.....	4-10
4.6.7	Burke-Gilman Trail	4-10
4.6.8	Fremont Canal Park	4-11
4.6.9	Ship Canal Access at Street Ends	4-11
4.7	Transportation	4-11
4.7.1	Roadway System	4-11
4.7.2	Transit	4-12
4.7.3	Nonmotorized Facilities.....	4-12
4.7.4	Freight Movement	4-13
4.7.5	Marine Traffic	4-13
4.8	Noise and Vibration	4-13
4.9	Energy and Climate Change	4-13
4.9.1	Energy.....	4-13
4.9.2	Climate Change	4-14
4.10	Historic, Cultural, and Archaeological Resources	4-14
4.10.1	Historic	4-14
4.10.2	Archaeological.....	4-15
4.10.3	Historic Properties in the Project Area	4-15
Section 5	Existing Conditions	5-1
5.1	Infrastructure Overview	5-1
5.2	Basins and Flow Routes.....	5-3

5.2.1	Seattle Public Utilities Ballard Combined Sewer Area (152 and 150/151)	5-3
5.2.2	King County Department of Natural Resources and Parks 11th Avenue NW Combined Sewer Area	5-4
5.2.3	Seattle Public Utilities Fremont and Wallingford Combined Sewer Areas (174 and 147)	5-4
5.2.4	King County Department of Natural Resources and Parks 3rd Avenue W Combined Sewer Area	5-5
5.2.5	DNRP Conveyance and Structures	5-5
5.3	Combined Sewer System Special Facilities	5-6
5.4	Combined Sewer Outfall Outfalls	5-7
5.5	Sewer Classification and Pipeline Information	5-8
5.6	Wastewater Treatment	5-9
5.7	Drainage System	5-9
5.8	Water and Sediment Quality of Combined Sewer Overflows	5-10
5.9	Receiving Water Quality	5-11
5.10	Infiltration and Inflow Studies	5-11
5.11	Sanitary Surveys for Unsewered Areas.....	5-12
Section 6	Historical Combined Sewer System Flows	6-1
6.1	Monitored Basin Flows	6-1
6.1.1	Temporary Flow Monitoring	6-1
6.1.2	No Impact Release Rate.....	6-2
6.1.3	Permanent Flow Monitoring.....	6-3
6.1.4	Rain Gauges.....	6-4
6.2	Modeled Basin Flows and Control Volumes.....	6-4
Section 7	Future Conditions.....	7-1
7.1	Future Demographics, Land Use, and Projected Population Levels	7-1
7.2	Projected Dry-Weather Flows.....	7-1
7.3	Projected Combined Sewer Overflow Frequency and Volume	7-2
7.4	Future Flow Reduction Options.....	7-2
Section 8	Options Development and Evaluation	8-1
8.1	Overview	8-1
8.2	Identified and Evaluated High-Level Combined Sewer Overflow Control Strategies	8-1
8.3	Developed and Evaluated Options	8-2
8.4	Evaluated Highest-Ranking Options to Select Recommended Option.....	8-3
8.4.1	Financing	8-4
8.4.2	Joint Project Benefits	8-4

8.4.3	Community Impacts	8-4
8.4.4	Regulatory Considerations	8-4
8.4.5	Lead Agency Designation and Responsibilities	8-5
8.5	Refining Recommended Option	8-5
8.6	Options Modeling	8-5
8.6.1	Options Modeling Methodology	8-5
8.6.2	Options Modeling Results	8-6
Section 9	Evaluation of Highest-Ranking Options	9-1
9.1	Combined Sewer Overflow Options	9-1
9.1.1	Option 1: Independent Tanks and Flow Transfer	9-1
9.1.2	Option 2: Independent Seattle Public Utilities Tunnel and King County Department of Natural Resources and Parks Tanks and Flow Transfer	9-3
9.1.3	Option 3: Shared Seattle Public Utilities and King County Department of Natural Resources and Parks Tunnel	9-4
9.2	Environmental Impacts	9-4
9.3	Public Involvement	9-5
9.4	Recommended Option	9-5
Section 10	Recommended Option	10-1
10.1	Overview	10-1
10.2	Layout	10-5
10.2.1	Proposed Facilities	10-5
10.2.2	Revisions to Existing Facilities and Site Access	10-7
10.2.3	Access to Proposed Facilities	10-8
10.2.4	Street Frontage Right-of-Way Improvements	10-8
10.2.5	Stormwater	10-8
10.2.6	Landscaping	10-9
10.2.7	Hydraulic Profiles	10-9
10.3	Storage Tunnel	10-9
10.4	Tunnel Access Locations	10-11
10.4.1	West Portal	10-11
10.4.2	11th Avenue Drop Shaft	10-11
10.4.3	North 3rd Avenue/174 Drop Shaft	10-12
10.4.4	South 3rd Avenue Drop Shaft	10-13
10.4.5	East Portal	10-13
10.5	Tunnel Effluent Pump Station	10-14
10.6	Auxiliary Portal and Drop Shaft Facilities	10-15
10.7	Basin 150/151 Conveyance	10-16
10.8	Basin 152 Conveyance	10-17

10.9	11th Avenue NW Conveyance	10-18
10.10	3rd Avenue W Conveyance.....	10-18
10.11	Basin 174 Conveyance	10-19
10.12	Basin 147 Conveyance and Pipe Storage.....	10-19
10.13	Operational Modes	10-20
	10.13.1 Mode 1: Tunnel Filling.....	10-21
	10.13.2 Mode 2: Tunnel Draining.....	10-21
	10.13.3 Mode 3: Tunnel Cleaning.....	10-21
	10.13.4 Mode 4: Standby Mode	10-22
	10.13.5 Mode 5: Continuous Operation (Filling/Draining)/System Optimization.....	10-22
	10.13.6 Mode 6: Manual Control.....	10-22
10.14	Sizing.....	10-23
10.15	Design Life	10-24
10.16	Solids Management.....	10-24
10.17	Ability to Provide Additional Control Volume	10-25
	10.17.1 Infiltration Reduction	10-25
	10.17.2 Residential RainWise Program	10-26
	10.17.3 Construct Additional Storage	10-26
10.18	Estimated Operations and Maintenance Staffing Needs.....	10-26
10.19	Design Parameters.....	10-29
	10.19.1 Site Selection	10-29
	10.19.2 Site Design.....	10-29
	10.19.3 Construction/Earthwork.....	10-29
	10.19.4 Structural/Geotechnical.....	10-29
	10.19.5 Stormwater.....	10-30
	10.19.6 Architecture and Landscaping.....	10-31
	10.19.7 Operations and Maintenance and Facility Inspection Considerations.....	10-31
10.20	Feasibility of Implementation.....	10-32
10.21	Environmental Impacts.....	10-32
	10.21.1 Earth and Groundwater.....	10-32
	10.21.2 Surface Water	10-34
	10.21.3 Odor and Air Quality.....	10-35
	10.21.4 Fisheries and Biological Resources	10-35
	10.21.5 Land and Shoreline Use and Visual Quality.....	10-36
	10.21.6 Recreation.....	10-38
	10.21.7 Transportation	10-40
	10.21.8 Noise and Vibration.....	10-41

10.21.9 Energy and Climate Change	10-42
10.21.10 Cultural Resources	10-43
Section 11 Financial Analysis	11-1
11.1 Cost Estimates	11-1
11.1.1 Background.....	11-1
11.1.2 Total Project Cost Estimate	11-2
11.1.3 Operations and Maintenance Cost Estimates	11-3
11.2 User Charges	11-5
11.2.1 Combined System Cost Allocation	11-5
11.2.2 Wastewater Rates	11-6
11.2.3 Drainage Rates.....	11-7
11.2.4 Seattle Public Utilities Financial Policies	11-9
11.2.5 King County Department of Natural Resources and Parks Financial Policies	11-9
11.3 Implementation Plan and Schedule.....	11-9
Section 12 Other Topics.....	12-1
12.1 Water Quality Management Plan Conformance	12-1
12.2 Project Identified in a General Sewer Plan, Capital Improvement Plan, and Long-Term Control Plan	12-1
12.3 State Environmental Policy Act Compliance	12-2
12.4 State Environmental Review Process Compliance	12-3
12.4.1 State Environmental Policy Act Documentation	12-3
12.4.2 Cost-Effective Analysis	12-3
12.4.3 Public Participation	12-4
12.5 Federal Cross-Cutters	12-4
12.5.1 National Historic Preservation Act	12-4
12.5.2 Clean Air Act.....	12-4
12.5.3 Coastal Zone Management Act	12-4
12.5.4 Endangered Species Act	12-5
12.5.5 Farmland Protection Policy Act.....	12-6
12.5.6 Executive Order 12898, Environmental Justice.....	12-6
12.5.7 Safe Drinking Water Act	12-6
12.5.8 Fish and Wildlife Coordination Act.....	12-7
12.5.9 Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat).....	12-7
12.5.10 Executive Order 11988, Floodplain Management.....	12-7
12.5.11 Executive Order 11990, Protection of Wetlands	12-7
12.5.12 Wild and Scenic Rivers Act	12-7

12.6	Growth Management Act.....	12-7
12.6.1	Comprehensive Plan Adopted.....	12-8
12.6.2	Critical Areas Ordinance Adopted	12-8
12.6.3	Development Regulations Adopted	12-9
12.7	Required Permits and Approvals.....	12-9
Section 13	References	13-1

List of Appendixes

- A Project Schedule
- B Public Involvement Documentation
- C Final Supplemental Environmental Impact Statement (provided on CD)

List of Tables

1-1	Consent Decree Milestone Dates Relevant to Facility Plan	1-3
1-2	Long-Term Modeling Results: CSO Frequencies, Overflow Volumes, and Control Volumes.....	1-6
1-3	Predicted CSO Frequency with Tunnel Volume Approximately Equal to the Combined Control Volumes: Based on 1990 to 2009 Rainfall	1-6
1-4	Projected Annual Cash Flow for the Ship Canal Water Quality Project	1-11
5-1	CSO Special Structures in Ship Canal Basins	5-7
5-2	General Characteristics of Ship Canal WQ Project Outfalls.....	5-8
5-3	SPU Separate Drainage System in the Project Area	5-10
6-1	Dry-Weather Flows in the Ship Canal Water Quality Project Basins.....	6-1
6-2	Temporary Monitoring Summary for Model Calibration.....	6-2
6-3	Ship Canal Water Quality Project Basins Reported CSO Frequency and Volumes 2010-2014	6-4
6-4	Long-Term Modeling Results (1978 to 2009): CSO Frequencies, Overflow Volumes, and Control Volumes.....	6-5
6-5	Predicted CSO Frequency with Tunnel Volume Approximately Equal to the Combined Control Volumes: Based on 1990 to 2009 Rainfall	6-6
8-1	Highest-Ranking Options Comparison	8-3
9-1	Capital, O&M, and Life-Cycle Present Value Costs for the Highest-Ranking Options	9-2
9-2	Shared SPU and DNRP Tunnel Option Advantages over Independent Tanks/Flow Transfer Options	9-6

9-3	Nonmonetized Evaluation Criteria	9-7
9-4	Nonmonetized Evaluation of Options 1 and 3	9-8
10-1	Design Flows and Hydraulic Conditions	10-24
10-2	Sizing of Ship Canal Water Quality Project Facilities	10-24
10-3	Routine Operation and Maintenance Activities for Ship Canal Water Quality Project Tunnel	10-27
11-1	Estimated Total Cost Projection for the Ship Canal Water Quality Project: 14-Foot-Diameter Tunnel Basis	11-3
11-2	Annual Operation and Maintenance Costs, 14-Foot Diameter Tunnel Basis ...	11-3
11-3	Present Value Operation and Maintenance and Replacement Costs for the Ship Canal Water Quality Project, 14-Foot-Diameter Tunnel Basis	11-4
11-4	SPU Monthly Wastewater Rates	11-7
11-5	Annual Drainage Rates	11-8
11-6	Projected Annual Cash Flow for the Ship Canal Water Quality Project	11-10
12-1	Coastal Zone Management Enforceable Policies	12-5
12-2	List of Anticipated Permits for the Ship Canal Water Quality Project	12-9

List of Figures

1-1	Conceptual Ship Canal Water Quality Project (SCWQP) System Illustration ..	1-11
1-2	Recommended Option Overview West	1-13
1-3	Recommended Option Overview East	1-15
1-4	West Portal and Ballard Conveyance Area	1-17
1-5	Effluent Discharge Pipeline Conveyance Overview	1-18
1-6	11th Avenue Drop Shaft And Conveyance Area	1-19
1-7	North 3rd Avenue/174 Drop Shaft and Conveyance Area.....	1-20
1-8	East Portal and Basin 147 Conveyance Area	1-21
4-1	Zoning	4-16
5-1	Existing Combined Sewer System Infrastructure	5-13
5-2	Basin 152 CSO Flow Schematic	5-14
5-3	Basin 150/151 CSO Flow	5-15
5-4	DNRP 11th Avenue NW Combined Sewer System.....	5-16
5-5	Basin 174 CSO Flow	5-17
5-6	Basin 147 CSO Flow	5-18

5-7	DNRP 3rd Avenue W Combined Sewer System	5-19
6-1	Schematic Dry-Weather Flow Summary for Basin 147	6-7
6-2	Schematic Dry-Weather Flow Summary for Basin 174	6-8
6-3	Schematic Flow Monitoring Summary for the 3rd Avenue W CSO Basin	6-9
6-4	Schematic Dry-Weather Flow Summary for Basin 150/151	6-10
6-5	Schematic Dry-Weather Flow Summary for the Outfall 152 Basin.....	6-11
6-6	Project Vicinity Rain Gauges	6-12
9-1	Evaluation of Highest Ranking Option: Independent Tanks and Flow Transfer	9-11
9-2	Evaluation of Highest Ranking Option: Independent SPU Tunnel, DNRP Tanks, and Flow Transfer.....	9-13
9-3	Evaluation of Highest Ranking Option: Shared SPU and DNRP Tunnel.....	9-15
10-1	Recommended Option Overview West	10-45
10-2	Recommended Option Overview East	10-47
10-3	Hydraulic Profile Storage Tunnel.....	10-49
10-4	Hydraulic Profile Tunnel Effluent Pump Station and Effluent Discharge Pipeline.....	10-51
10-5	Hydraulic Profile Outfalls 150/151/152 Connection Pipelines	10-53
10-6	Hydraulic Profile 11th Ave W CSO Connection Pipeline	10-55
10-7	Hydraulic Profile 3rd Ave W CSO Connection Pipeline.....	10-57
10-8	Hydraulic Schematic Profile.....	10-59
10-9	Hydraulic Profile Outfall 147 Connection Pipeline	10-61
10-10	Tunnel Effluent Pump Station – Finished Plan	10-63
10-11	Tunnel Effluent Pump Station Sections 3D Views.....	10-65
10-12	Tunnel Effluent Pump Station 3D Views.....	10-67
10-13	11th Ave Drop Shaft – Finished Plan	10-69
10-14	11th Ave Drop Shaft – Finished Site Plan	10-71
10-15	11th Ave Drop Shaft – 3D Views	10-73
10-16	11th Ave Drop Shaft – 3D Views	10-75
10-17	North 3rd Ave/174 Finished site Plan	10-77
10-18	North 3rd Ave/174 – Finished Site Plan	10-79
10-19	North 3rd Ave/174 – 3D Views	10-81
10-20	North 3rd Avenue/174 – 3D Views	10-83

10-21	South 3rd Avenue Drop Shaft – Finished Site Plan.....	10-85
10-22	South 3rd Avenue Drop Shaft – 3D Views	10-87
10-23	South 3rd Avenue Drop Shaft – 3D Views	10-89
10-24	East Portal – finished Site Plan	10-91
10-25	East Portal 3D Views.....	10-93
10-26	East Portal – 3D Views.....	10-95

Facility Plan Acronyms

AACE	American Association of Cost Engineering
BMP	best management practice
cfm	cubic feet per minute
CIP	Capital Improvement Program
CN	Conservation Navigation
CO ₂ e	carbon dioxide equivalent
CSO Control Plan Amendment	<i>2012 King County Long-term Combined Sewer Overflow Control Plan Amendment</i>
CSO	combined sewer overflow
CWA	Clean Water Act
DAHP	Washington State Department of Archaeology and Historic Preservation
DDT	dichlorodiphenyltrichloroethane
DNRP	King County Department of Natural Resources and Parks, Wastewater Treatment Division
DOJ	U.S. Department of Justice
DSN	Discharge Serial Number
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FAS	City of Seattle Department of Finance and Administrative Services
GDR	Geotechnical Data Report

GAR	Geotechnical Assessment Report
GMA	Growth Management Act
GSI	green stormwater infrastructure
HDPE	high-density polyethylene
I&I	inflow and infiltration
ID	inside diameter
IG	Industrial General
JPA	Joint Project Agreement
LTCP	Long Term Control Plan, Volume 2 of the <i>Plan to Protect Seattle's Waterways</i>
Metro	Municipality of Metropolitan Seattle
MG	million gallons
MGD	million gallons per day
MH	maintenance hole
MTCA	Model Toxics Control Act
NIRR	no impact release rate
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NW	northwest
O&M	operations and maintenance
OHWM	ordinary high water mark
PCMP	Post-Construction Monitoring Program
P&ID	process and instrumentation diagram
Plan	<i>Plan to Protect Seattle's Waterways</i> (SPU, 2015)
QAPP	quality assurance project plan

RCW	Revised Code of Washington
RWSP	Regional Wastewater Services Plan
SCADA	supervisory control and data acquisition
SDOT	Seattle Department of Transportation
SEIS	Supplemental EIS
SEPA	State Environmental Policy Act
SERP	State Environmental Review Process
Ship Canal WQ Project	Ship Canal Water Quality Project
SMC	City of Seattle Municipal Code
SMP	Shoreline Management Plan
SPU	Seattle Public Utilities
SRF	State Water Pollution Control Revolving Loan Fund
SWMM	U.S. Environmental Protection Agency Storm Water Management Model
TBL	triple bottom line
TEPS	Tunnel Effluent Pump Station
UG	Urban General
UI	Urban Industrial
U.S.C.	United States Code
W	West
WAC	Washington Administrative Code
WISAARD	Washington Information System for Architectural and Archaeological Records Data
WQ	Water Quality

This page intentionally left blank.

1 Executive Summary

1.1 Background

This Facility Plan outlines sewer system improvements that are necessary to reduce combined sewer overflows (CSOs) from Seattle Public Utilities' (SPU's) Ballard, Fremont, and Wallingford areas and King County Department of Natural Resources and Parks (DNRP's) 11th Avenue NW and 3rd Avenue W Basins. Figure 1-1 shows the Ship Canal Water Quality (WQ) Project (also called the Ship Canal Project and formerly called the Shared West Ship Canal Tunnel Option) conceptual system illustration.

To help control CSOs from these areas, various storage and flow transfer concepts were evaluated in SPU's *Plan to Protect Seattle's Waterways* (the Plan; SPU, 2014a and 2015a) and DNRP's *2012 King County Long-term Combined Sewer Overflow Control Plan Amendment* (CSO Control Plan Amendment; King County, 2012a). The Ship Canal WQ Project was selected as the recommended option by both agencies. This Facility Plan describes the project components and other key considerations of the recommended option.

The City of Seattle (City) originally constructed a combined sewer system in the Ship Canal WQ Project area (project area), meaning that both sanitary sewage (sewage) and stormwater runoff are conveyed in the same pipes. The City, and later, SPU, modified the sewer system over time. Some portions of the project area now have fully separated sewers, meaning that sewage and stormwater are collected and conveyed in separate systems. Other portions of the project area have partially separated sewers, meaning that stormwater from roof drains and foundations enters the sanitary sewer system, while stormwater from roadways enters a separate drainage system.

Much of DNRP's system of regional interceptors was constructed before it was transferred to the Municipality of Metropolitan Seattle (Metro). Metro was formed through a referendum in 1958 and was the precursor regional wastewater agency to DNRP. Metro expanded the system in the 1960s and 1970s as part of a regional wastewater management strategy to reduce pollution to local water bodies. While some parts of DNRP's collection system are fully separated, the interceptors in the project area are considered combined sewers. Flows from the project area are conveyed to DNRP's West Point Treatment Plant for secondary treatment and ultimately discharged to Puget Sound. DNRP designed, sized, and built West Point Treatment Plant as part of its CSO control planning to provide full secondary treatment for 300 million gallons per day (MGD) and to provide primary treatment and disinfection for an additional 140 MGD.

Portions of the Ship Canal WQ Project basins have partially separated sewer systems, where stormwater from private property (for example, roof drains) typically enters the sanitary sewer system, while stormwater from public property (for example, streets) typically enters a separate drainage system. For partially separated systems, under wet-weather conditions, flows are a combination of sewage and stormwater. As long as the flows are within the capacity of the sewer system, the pipes convey all flows to the West Point Treatment Plant. However, if flows exceed the capacity of the sewer system, then the excess volume of sewage and stormwater discharges into receiving water bodies through CSO outfalls. For this project, these receiving water bodies are Lake Union, Lake Washington Ship Canal (Ship Canal), and Salmon Bay Waterway.

1.2 Regulatory Requirements

The following laws and regulations require that the City and King County limit CSOs to a 20-year moving average of no more than one untreated discharge per year per permitted outfall:

- **Revised Code of Washington (RCW) 90.48.480**—This law requires “the greatest reasonable reduction of combined sewer overflows.”
- **Washington Administrative Code (WAC) 173-245-020 (22)**—“‘The greatest reasonable reduction’ means control of each CSO in such a way that an average of one untreated discharge may occur per year.”
- **City’s and King County’s National Pollutant Discharge Elimination System (NPDES) permits and Consent Decrees**—These direct that a moving 20-year period be used for long-term averaging of the overflow frequency (United States of America, 2013a and 2013b).

SPU’s Ballard, Fremont, and Wallingford CSO outfalls (Outfalls 147, 150, 151, 152, and 174) and DNRP’s 3rd Avenue W (008) and 11th Avenue NW (004) outfalls exceed a 20-year moving average of one untreated discharge per year. These CSO outfalls are the focus of the CSO control measures described in this Facility Plan.

The following key terms relate to the volume and frequency requirements:

- **Control volume**—The amount of excess combined sewage that must be captured or intercepted upstream of the outfall such that a 20-year moving average of no more than one untreated discharge per year per outfall is achieved.
- **Storage volume**—The actual size of the facility that needs to be constructed to operate and meet the control volume requirement for all CSO basins being controlled under various conditions.

The storage volume is not necessarily the same as the control volume. Storage volume differs in that it depends on additional factors, including the following: 1) system

hydraulics, 2) storage location, 3) control system, and 4) timing of the release of stored volumes to avoid impacts to downstream facilities.

The required minimum control volume for the various project area basins, based on hydraulic and hydrologic modeling completed as part of the *Plan to Protect Seattle's Waterways*, is 15.24 million gallons (MG). The actual storage volume will be confirmed during project design. The SPU and DNRP project team will consider various tunnel diameters during project design; each would provide or exceed the required control volume.

King County and the City of Seattle have entered into a Joint Project Agreement (JPA) that defines the joint project and the roles and responsibilities for each agency. King County's participation as a partner with SPU on the Ship Canal Project has been approved and documented by modification to its Consent Decree with the United States Environmental Protection Agency (EPA) and State of Washington Department of Ecology (Ecology), filed October 25, 2016 with the United States District Court, Western District of Washington (United States of America, 2016). Table 1-1 shows Consent Decree milestones dates for the joint project.

Table 1-1. Consent Decree Milestone Dates Relevant to Facility Plan

Ship Canal WQ Project Milestone	SCWQP Consent Decree Milestone Dates^a
Submit Draft Engineering Report for Ship Canal WQ Project	March 31, 2017
Submit Final Engineering Report for Ship Canal WQ Project	December 31, 2017
Submit Draft (90 percent) plans and specifications to Ecology for Ship Canal WQ Project	March 31, 2020
Submit Final (100 percent) plans and specifications to Ecology for Ship Canal WQ Project	December 31, 2020
Start construction for Ship Canal WQ Project	July 1, 2021
Complete construction of Ship Canal WQ Project	December 31, 2025
Achieve control status for combined sewer basins controlled by Ship Canal WQ Project	December 31, 2026

^a Dates per the approved Final Plan (SPU, 2015a).

1.3 Combined Sewer Overflow Control Options Development and Evaluation

The Draft SPU Long Term Control Plan (LTCP; Volume 2 of the *Plan to Protect Seattle's Waterways*; SPU, 2014a) detailed and evaluated the following four options for controlling CSOs in the Ballard, Fremont, and Wallingford neighborhoods as part of the Ship Canal WQ Project:

- SPU independent tanks and flow transfer projects (multiple storage tanks and flow transfers) and DNRP independent storage and flow transfer projects
- SPU independent tunnel and DNRP independent storage and flow transfer projects
- Combination of independent SPU and DNRP storage and flow transfer projects plus shared SPU and DNRP storage facilities
- Two shared SPU and DNRP tunnel projects

The recommended option for the Final SPU LTCP was identified using a triple bottom line (TBL) analysis of the highest-ranking options. TBL is an economic analysis technique that evaluates financial, social, and environmental costs, benefits, and risks of each option.

The shared SPU and DNRP Ship Canal WQ Project was found to be comparable in cost with other options to control CSOs, given the early stage of option development and uncertainty of cost estimating. The independent tanks and flow transfer projects option had similar capital costs based on the American Association of Cost Engineering (AACE) Class 4 level of cost uncertainty, but greater construction impacts and less future flexibility. SPU and DNRP agreed that the shared SPU and DNRP Ship Canal WQ Project was the preferred option for the Ship Canal area. This recommendation was included in the Final SPU LTCP, which was approved by EPA and Department of Ecology on August 26, 2015. The following factors support this recommendation:

- The project will result in lower overall community impacts:
 - Significantly less truck traffic by using alternative rail or barge transportation of spoils and materials from the tunnel construction site,
 - Less surface excavation with the tunnel compared with tanks
 - Less conveyance with the tunnel, so less excavation occurring at surface excavation sites in the right-of-way compared with tanks
 - Shorter length of open cut pipeline construction disrupting street rights-of-way
 - Lower risk of encountering, handling, and remediating contaminated soils at the surface
- Both SPU and DNRP will gain greater operational flexibility and lower risk of compliance failure, provided by the aggregated storage volume serving the multiple CSOs in the project area. Centralized storage will offer benefit of reducing maintenance of DNRP and SPU infrastructure. Centralized storage also will offer the benefit of adding future capacity with fewer impacts.
- Less property will be required, and there will be less surface impact on required property; there will be an opportunity to surplus a significant portion of acquired property post-construction or to repurpose the property for beneficial public use.

- Most key property acquisition for the tunnel is already in progress by SPU, whereas independent tank-based storage would require a siting and property acquisition process for the DNRP tank and appurtenances. SPU would also need additional siting and property acquisition for independent tank-based storage. The anticipated duration of additional property siting and acquisition is a considerable risk to the overall compliance schedules for SPU and DNRP and is mitigated through the joint tunnel project.
- There will be greater opportunity for spoils disposal using barges or rail transport.
- Fewer pump stations will be required.

In addition, when viewed with greater attention toward nonmonetary considerations, the shared Ship Canal WQ Project tunnel option offers advantages over the independent tank-based storage and flow transfer options (see Table 9-2 in Chapter 9). Nonmonetary factors, such as social and environmental objectives, risk, and benefits were used to evaluate options in conjunction with other factors (see Tables 9-3 and 9-4 in Chapter 9).

The Facility Plan continues refining the recommended option from the Final SPU LTCP (SPU, 2015a). Additional engineering and scientific analyses were completed to better define physical project characteristics, assess environmental and community impacts, and refine project cost estimates.

1.4 Recommended Option

The Ship Canal WQ Project will provide offline storage of combined wastewater in a deep storage tunnel constructed between the Ballard and Wallingford CSO areas, on the north side of the Ship Canal. The project will control the Ballard CSO basins (Outfalls 150, 151, and 152), Fremont (Outfall 174) and Wallingford (Outfall 147) CSO basins, DNRP 3rd Avenue W Overflow Structure (DSN008), and 11th Avenue NW Overflow Structure (DSN004). Figures 1-2 and 1-3 provides a plan view of the Ship Canal WQ Project location and components.

Flow monitoring data and hydraulic modeling analysis both indicate the Ship Canal CSO outfalls currently exceed the one untreated discharge per year regulatory standard. Table 1-2 shows the predicted annual CSO frequency and volume and the control volume for each outfall that will be controlled by this project. These CSO statistics were derived from a series of 32-year simulations with calibrated hydraulic models and represent how the existing system performs under a wide variety of historical climate conditions.

Table 1-2. Long-Term Modeling Results: CSO Frequencies, Overflow Volumes, and Control Volumes ^a

Outfall	Average Number of CSO Events Per Year	Average Annual CSO Volume (MG)	Control Volume (MG)
Outfall 147	41.9	8.9	2.15
Outfall 174	8.6	3.8	1.06
3rd Avenue W ^b	16.8	17.5	4.18
11th Avenue NW ^b	16.1	11.2	1.85
Outfall 150/151	16.0	2.9	0.62
Outfall 152	47.8	23.5	5.38
TOTAL	147.2	67.8	15.24

^a The SPU control volumes account for future climate change and were identified through hydraulic modeling presented in the *Plan to Protect Seattle's Waterways, Volume 2* (SPU, 2015a), with boundary conditions provided for the DNRP combined sewer conveyance system. The DNRP control volumes were presented in King County's 2012 Long-Term CSO Control Plan Amendment (King County, 2012a).

^b These are DNRP outfalls. 3rd Avenue W is also referred to as DSN 008 and 11th Avenue NW referred to as DSN 004.

DSN: discharge serial number

Table 1-3 shows the estimated frequency of CSO discharges after the recommended project is implemented based on a 1990-to-2009 simulation conducted with calibrated CSO models (see *Plan to Protect Seattle's Waterways, Volume 2: LTCP, Appendix L, Section 13* for additional details).

The main components of the Ship Canal WQ Project include the storage tunnel and appurtenances, conveyance facilities to convey SPU and DNRP CSO flows into the tunnel, and a pump station and effluent discharge pipeline to drain flows from the tunnel. The modeling results indicate the Ship Canal WQ Project would reduce CSO frequencies to less than one per year at each outfall.

Table 1-3. Predicted CSO Frequency with Tunnel Volume Approximately Equal to the Combined Control Volumes: Based on 1990 to 2009 Rainfall

Outfall	Average Number of CSO Events Per Year
147	0.6
174	0.5
3rd Avenue W	0.5
11th Avenue NW	0.4
150/151	0.6
152	0.7

Note: The SPU design storage volumes account for future climate change and were identified through hydraulic modeling of the CSO control measure concepts presented in the Plan to Protect Seattle's Waterways, Volume 2, with boundary conditions provided for the DNRP combined sewer conveyance system.

These main components listed below were identified during conceptual planning and are shown on Figures 1-4 through 1-8:

- A minimum 15.24-MG offline storage tunnel will have a minimum 14-foot nominal inner diameter (ID), measuring approximately 14,000 feet long.
 - The stored combined sewage in the storage tunnel will flow from the East Portal in Wallingford westward to the Tunnel Effluent Pump Station (TEPS) in Ballard.
 - The tunnel alignment is planned to be primarily in the street right-of-way along the north side of the Ship Canal.
- Seven diversion structures will divert combined sewage away from existing CSO outfalls to the tunnel.
- Five drop structures will convey combined sewage from the surface into the storage tunnel; four structures will have odor control systems.
- A pump station will be located at the West Portal with an average capacity of 32 MGD to empty the storage tunnel in approximately 12 hours based on current design criteria.

Conveyance facilities will include the following elements listed below; all conveyance sizing and quantities are approximate estimates based on current design to date, and actual diameters, lengths, and alignments of conveyance facilities will be determined during the final phase:

- Gravity sewer line to convey flows from SPU's diversion structure at Ballard Outfalls 151 (approximately 440 linear feet of 36- to 48-inch-diameter pipe) and 152 (approximately 2,200 linear feet of 60-inch-diameter pipe) to the tunnel drop shaft
- Gravity sewer line to convey flows from DNRP's diversion structure at 11th Avenue NW to the tunnel drop shaft (approximately 120 linear feet of 60-inch to 72-inch-diameter pipe)
- Gravity sewer line to convey flows from SPU's diversion structure at Fremont Outfall 174 to the tunnel drop shaft (approximately 200 linear feet of 30- to 36-inch-diameter pipe)
- Gravity sewer line to convey flows from DNRP's diversion structure at 3rd Avenue W (under the Ship Canal) to the tunnel drop shaft (approximately 740 linear feet 18- to 60-inch-diameter diameter pipe)
- Gravity sewer line to convey flows from SPU's diversion structure at Wallingford Outfall 147 to the tunnel drop shaft (approximately 1,000 linear feet of 24- to 30-inch-diameter pipe)
- Effluent discharge piping to convey flows from the TEPS to SPU's local sewer (approximately 100 linear feet of 24-inch-diameter pipe) and DNRP's existing Ballard

Siphon wet-weather barrel forebay (approximately 1,900 linear feet of effluent discharge pipe that ranges from 24- to 72-inch-diameter).

Gravity sewer lines to convey flows from SPU's diversion structures at Ballard Outfalls 151 and 152 and Wallingford Outfall 147 to the tunnel drop shafts have been excluded from the cost sharing agreement between SPU and DNRP and are the sole responsibility of SPU.

Following are key system components of the recommended option:

- **Storage Tunnel**—The baseline storage tunnel has a minimum 14-foot nominal inner diameter with a minimum of 15.24 MG storage capacity; the actual diameter will be determined during project design. To determine a project envelope of construction and environmental impacts and costs, the tunnel turning radii and construction shaft sizing are based on a maximum 18-foot-diameter tunnel. The tunnel will have a depth of 50 to 100 feet, for most of the alignment, depending on the alignment revisions during the project final design. Flows will enter the storage tunnel by gravity and be pumped to the local SPU sewer and DNRP regional interceptor when downstream capacity in these systems is available. A flushing system at the East Portal will be used to clean the storage tunnel following operation to remove accumulated solids and debris.
- **TEPS**—A 32-MGD pump station will be constructed at the West Portal, located within the deep shafts used to construct the tunnel. An above-grade building will provide secured access to the pump station dry-well and wet-well areas. An on-site diesel-powered generator will provide standby power. The TEPS will be designed for automated operation (unstaffed) and include safety and ventilation systems; electrical and control systems; access considerations and spatial considerations for on-site maintenance; permanent lifting equipment; and other operational systems required for safe long-term O&M activities.
- **Drop Shafts, Portals, and Vortex Drop Structures**—Drop shafts and portals are finished facilities that will be located along the tunnel alignment providing conveyance functions and tunnel access. Located within the West Portal (wet well), 11th Avenue NW Drop Shaft, North 3rd Avenue/174 Drop Shaft, South 3rd Avenue Drop Shaft, and East Portal, vortex drop pipes will convey flows vertically downward from near-surface conveyance pipelines to the storage tunnel and allow movement of air to the odor control facilities. The drop shafts and portals will also provide access to the tunnel along the alignment for entry into the tunnel by SPU maintenance staff as needed. Small standby generators located at the portals and most drop shafts will provide sufficient power for instrumentation and nearby control gates located at conveyance system diversion structures.

- **Conveyance**—This project will include structures needed to intercept combined sewer flows during storm events from the SPU and DNRP CSO basins. Gravity pipelines will convey flows to the storage tunnel. Diversion structures with control gates will direct water either into the tunnel or to existing outfalls. Conveyance elements will also include the TEPS effluent discharge pipeline that will convey flows to the Ballard Regulator Station and may include a new grit removal structure in the Basin 152 collection system upstream of the CSO interception structures. The primary anticipated construction method for conveyance pipes will be open-cut construction. Some sections will be constructed using microtunneling (trenchless method) to avoid extended surface impacts; cross under critical utilities, railroads, and streets; and to construct the 3rd Avenue W CSO connection under the Ship Canal to the North 3rd Avenue/174 Drop Shaft. Real-time controls, including automated adjustable gates, and level and flow sensors will be included at diversion structures and actively control flows entering the storage tunnel and determine flows diverted to the existing outfalls.
- **Odor Control**—An odor control system incorporating a fan and activated carbon-scrubbing media to treat foul air from the tunnel will be located at the TEPS. An underground electrical and mechanical vault containing an activated carbon odor control system, mechanical, electrical, and control systems will be located at the 11th Avenue and North 3rd Avenue/174 Drop Shafts and at the East Portal. Odor control will be provided to South 3rd Avenue from the North 3rd Avenue/174 odor control system. Odor control at other locations will be evaluated during final design.
- **Modifications to Existing System**—Existing structures may be modified based on the results of hydraulic modeling that will be performed during design.

All conveyance sizing and quantities, including the storage tunnel, are estimates based on conceptual planning to date. Actual diameters and lengths of conveyance facilities, tunnel depth and diameter, and size and function of associated facilities, including pumping systems, odor control, and standby power, will be determined during the project design phase.

In addition to the key system components described above, the project will incorporate the following elements:

- **24th Avenue NW Pedestrian Pier Improvements**—A considerable portion of tunnel construction spoils and other waste materials will be transported to a disposal site using barges. The existing 24th Avenue NW Pedestrian Pier located adjacent to the West Portal will require reconstruction in its current location to accept the anticipated loading equipment required for the effective use of barges. When the project is completed, the reconstructed pier will be converted back to a public amenity.

- **Outfall 151 Rehabilitation**—The existing 18-inch-diameter wood-stave Outfall 151 is in poor condition, and rehabilitating it during Ship Canal Project construction will be less disruptive to the community than constructing a separate rehabilitation project. SPU plans to replace both the existing Outfall 151 and the existing 30-inch-diameter high-density polyethylene (HDPE) Outfall 150 with a single HDPE 48-inch-diameter outfall. This replacement Outfall 151 will be installed under the new 24th Avenue NW Pedestrian Pier.

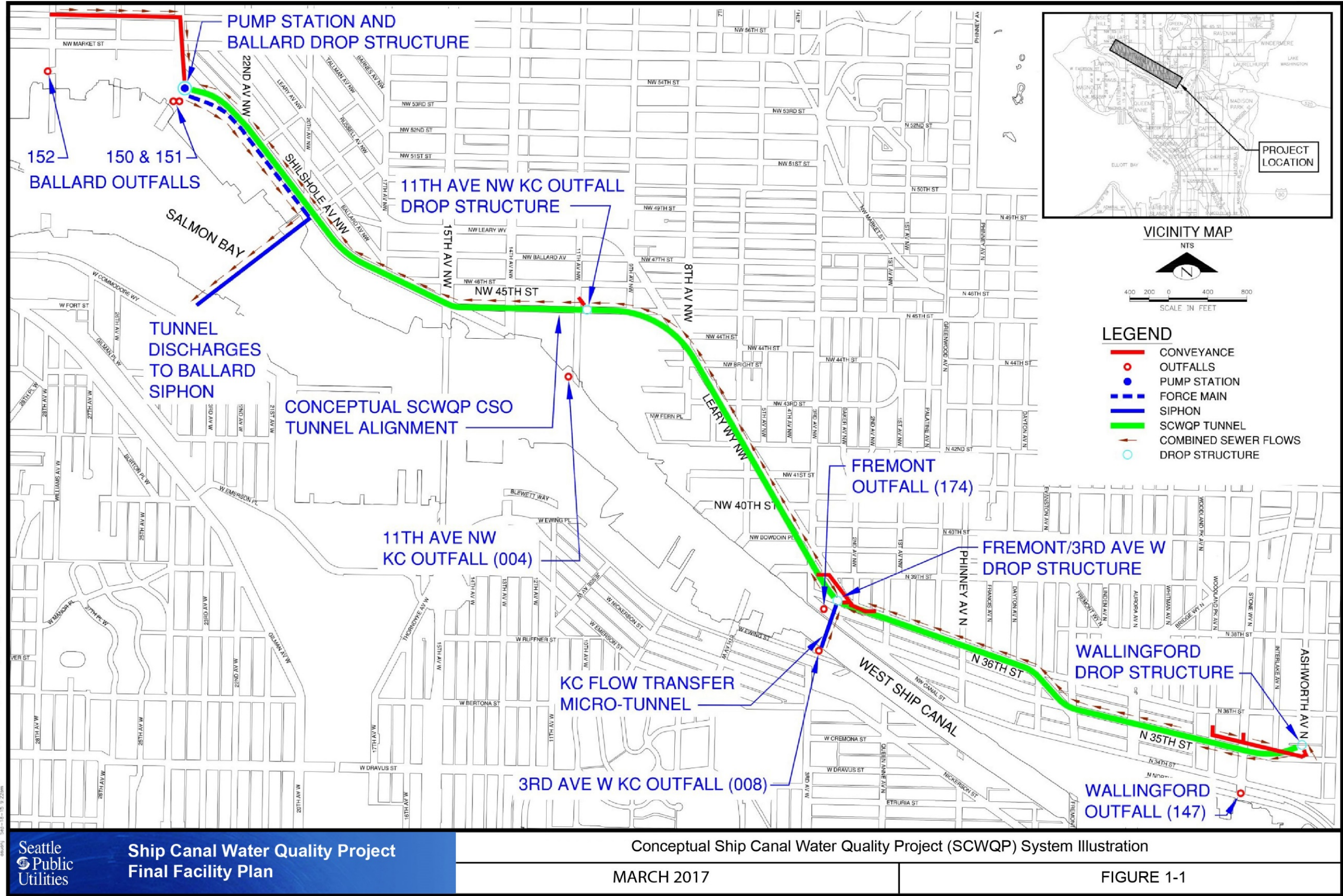
After the Ship Canal WQ Project is constructed and operating, CSOs will occur only during extreme storm events when the capacity of the tunnel is exceeded. During less extreme events, stored flows will drain from the tunnel to the West Point Treatment Plant for treatment after rainfall ends and/or conveyance capacity is available.

Table 1-4 shows the projected annual cash flow for the Ship Canal WQ Project based on the project schedule included in Appendix A. The schedule and cash flow were developed in December 2016 and are subject to change as the project schedule is updated. The dollars are escalated to the year in which the costs are projected to occur. For example, the amounts for 2017 are expressed in 2017 dollars while the amounts for 2018 are expressed in 2018 dollars. A 2-percent annual inflation rate was used for the cost escalation. The dollars are based on the total cost projection presented in Table 11-1 in Chapter 11 (14-foot-diameter tunnel basis). The cost share between SPU and DNRP is discussed in Chapter 12.

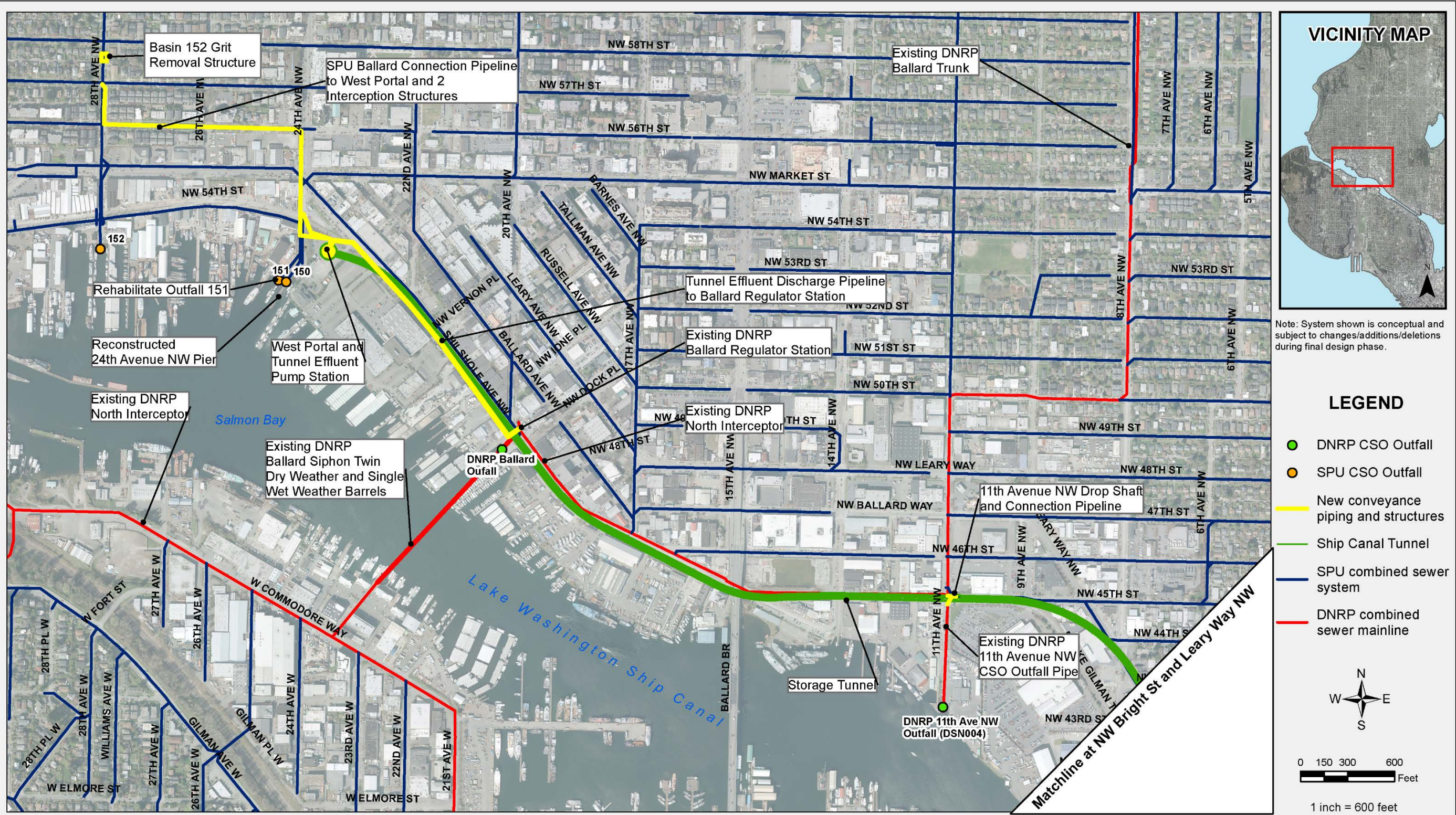
Table 1-4 Projected Annual Cash Flow for the Ship Canal Water Quality Project	
Year	Annual Cash Flow ^a
Prior Years ^b	\$38,200,000
2017	\$10,000,000
2018	\$15,900,000
2019	\$24,800,000
2020	\$71,000,000
2021	\$101,600,000
2022	\$72,500,000
2023	\$47,300,000
2024	\$32,400,000
2025	\$9,700,000
TOTAL	\$423,400,000

^a The amounts in future years (i.e., 2017 and beyond) are adjusted for inflation

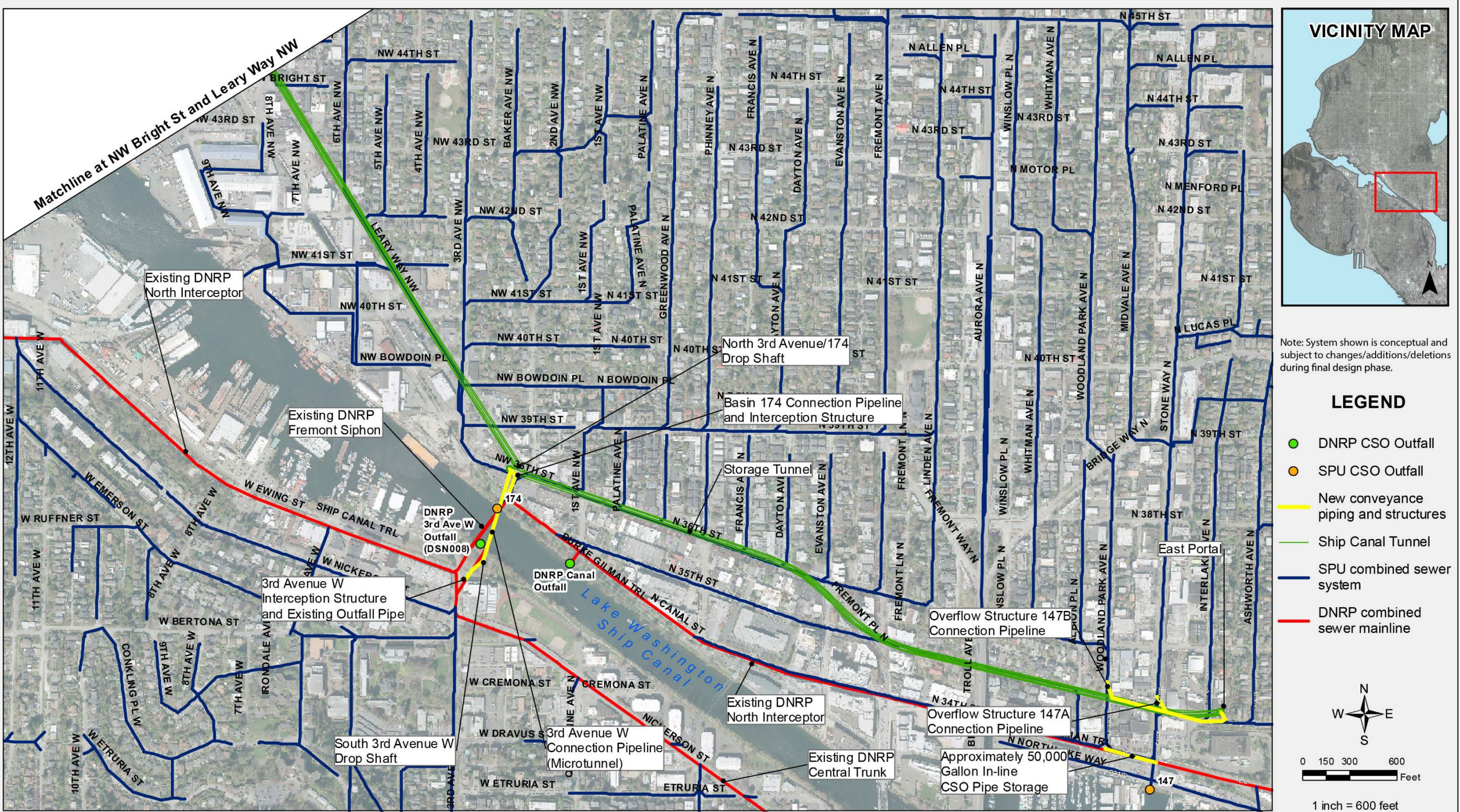
^b The amount from prior years is based on actual dollars spent.




This page intentionally left blank.

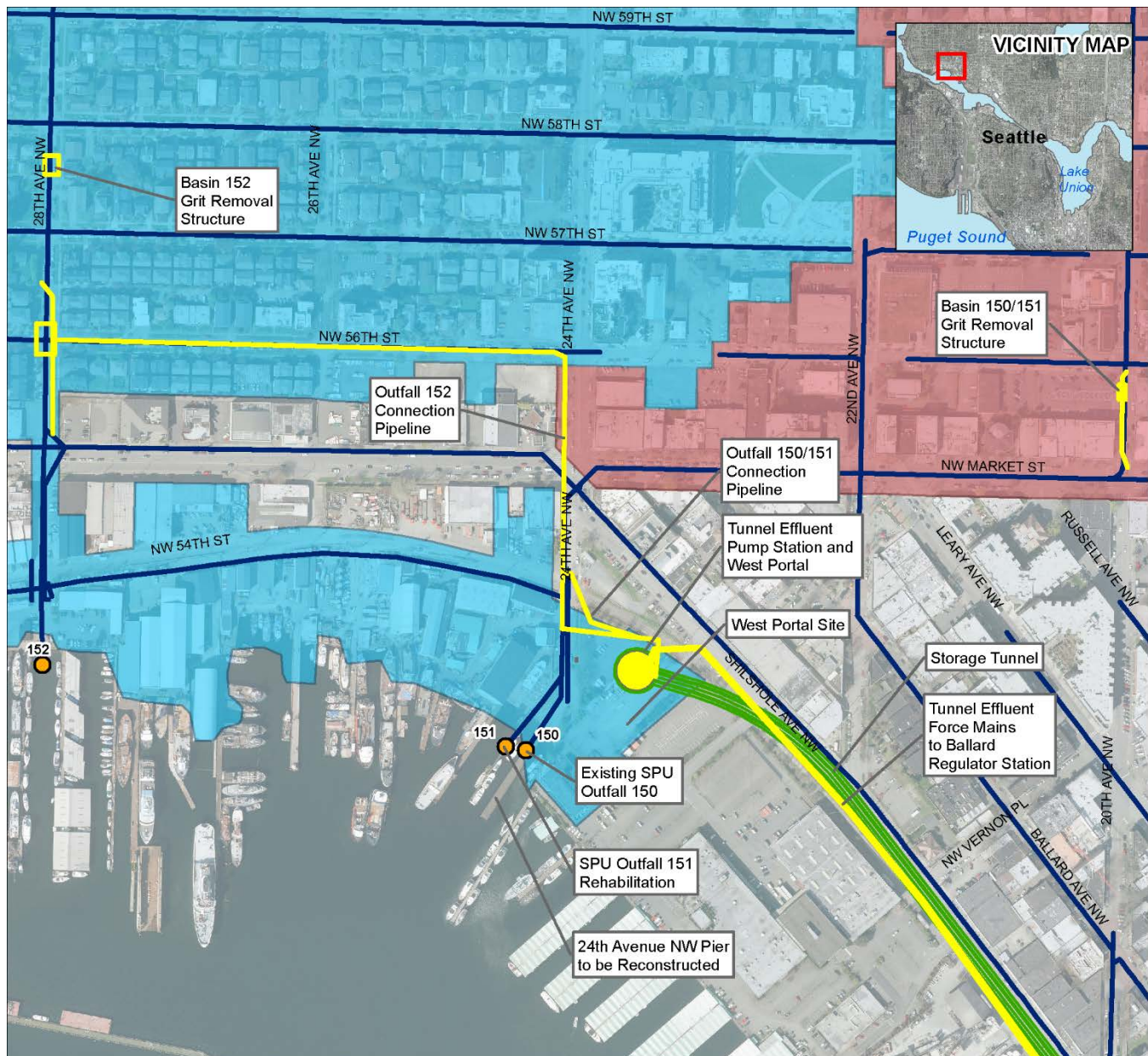


This page intentionally left blank.



	Ship Canal Water Quality Project Final Facility Plan		RECOMMENDED OPTION OVERVIEW EAST	
			MARCH 2017	FIGURE 1-3

This page intentionally left blank.



Note: System shown is conceptual and subject to changes/additions/deletions during final design phase.



LEGEND

- New conveyance piping and structures
- Ship Canal Tunnel
- SPU Basin 150/151 (Ballard)
- SPU CSO Outfall
- SPU combined sewer system
- SPU Basin 152 (Ballard)

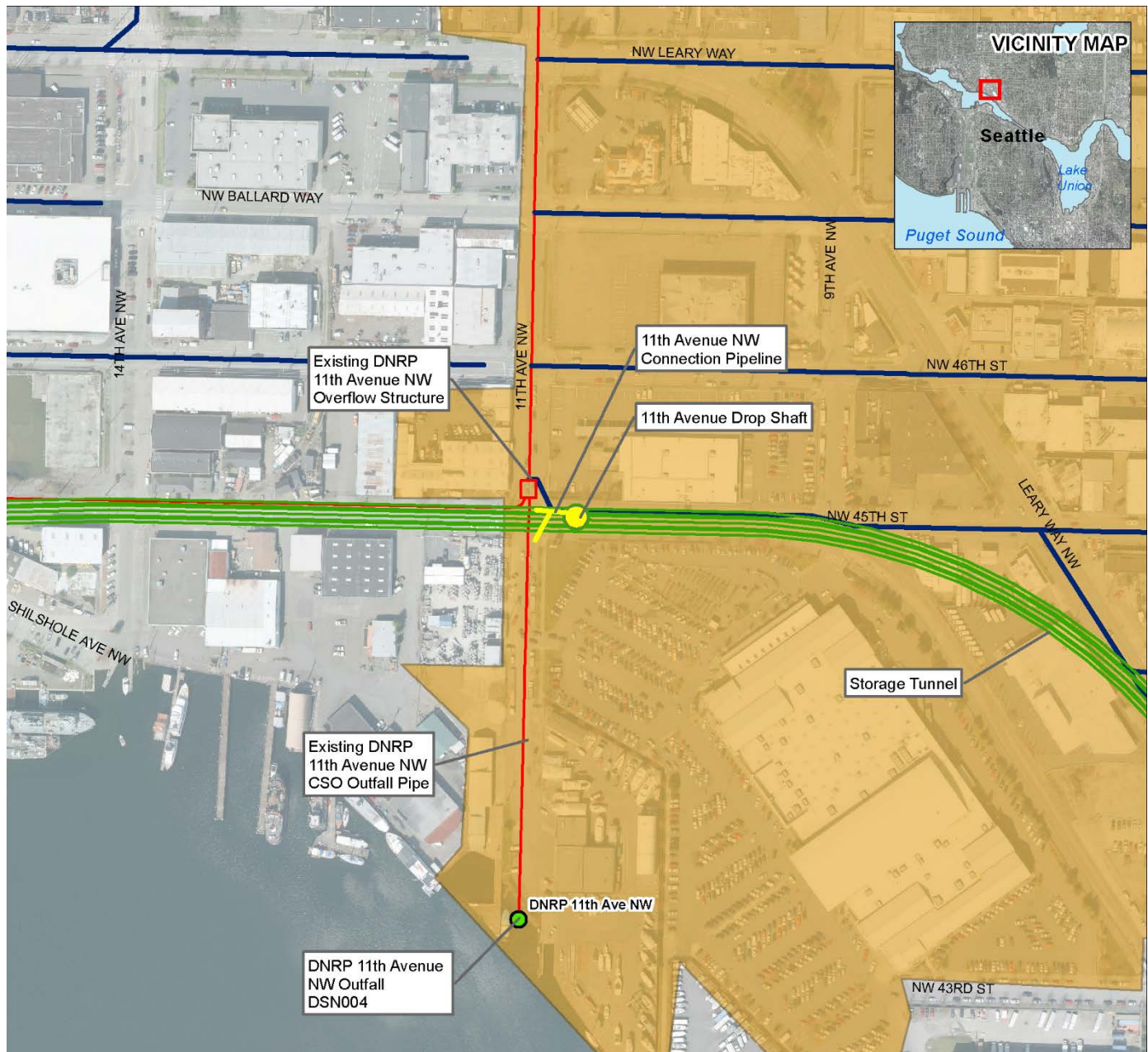
Seattle
Public
Utilities

Ship Canal Water Quality Project Final Facility Plan

West Portal and Ballard Conveyance Area

March 2017

Figure 1-4



Note: System shown is conceptual and subject to changes/additions/deletions during final design phase.

LEGEND

- DNRP CSO Outfall
- Ship Canal Tunnel
- DNRP 11th Ave NW
- New conveyance piping and structures
- DNRP combined sewer mainline
- SPU combined sewer system

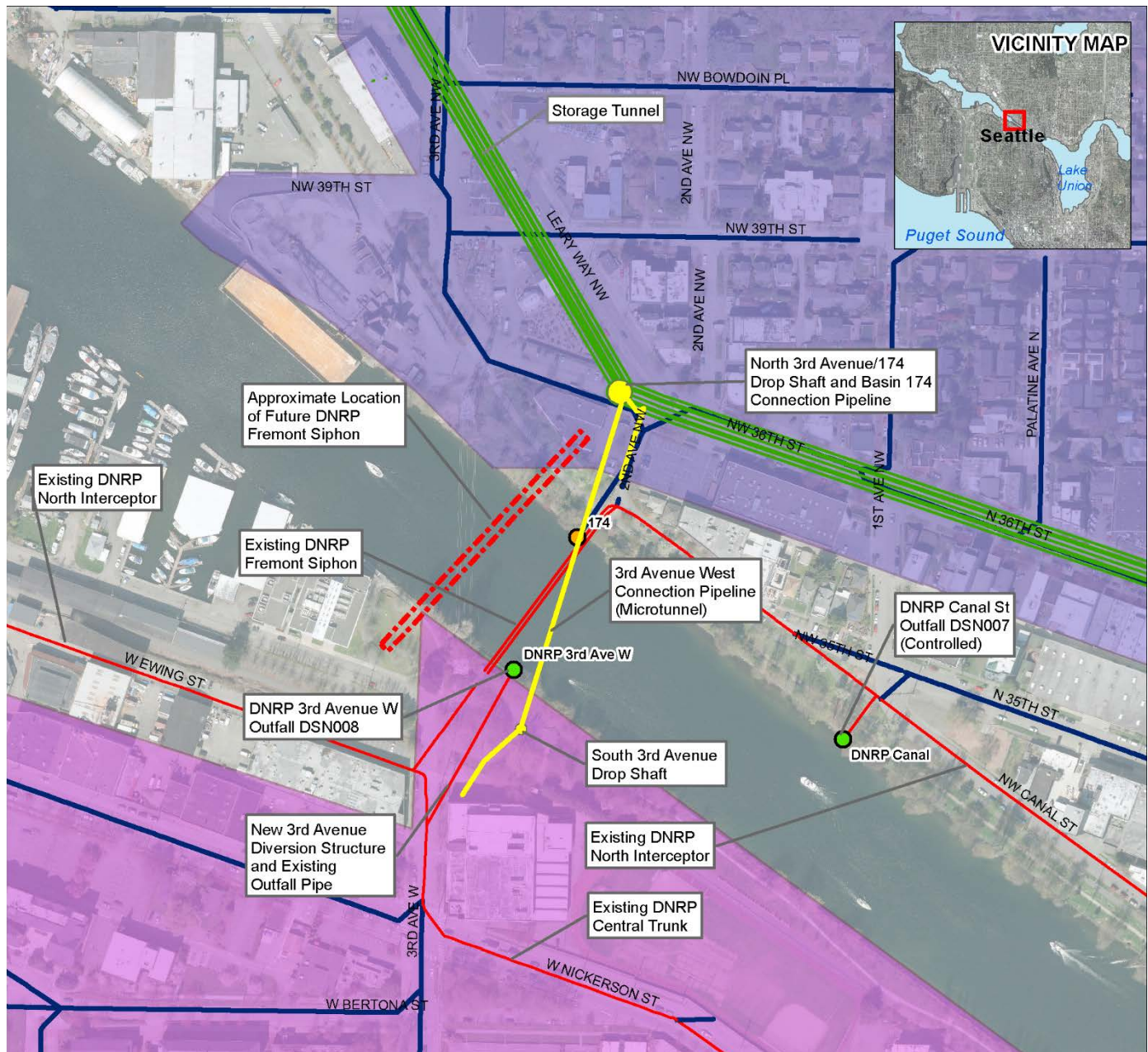
Seattle
Public
Utilities

Ship Canal Water Quality Project Final Facility Plan

11th Avenue Drop Shaft and Conveyance Area

March 2017

Figure 1-6



Note: System shown is conceptual and subject to changes/additions/deletions during final design phase.



LEGEND

- | | | |
|--|---|---|
| ● DNRP CSO Outfall | — Ship Canal Tunnel | DNRP 3rd Ave W |
| ● SPU CSO Outfall | - - - Future siphon | SPU Basin 174 (Fremont) |
| — New conveyance piping and structures | — DNRP combined sewer mainline | |
| | — SPU combined sewer system | |

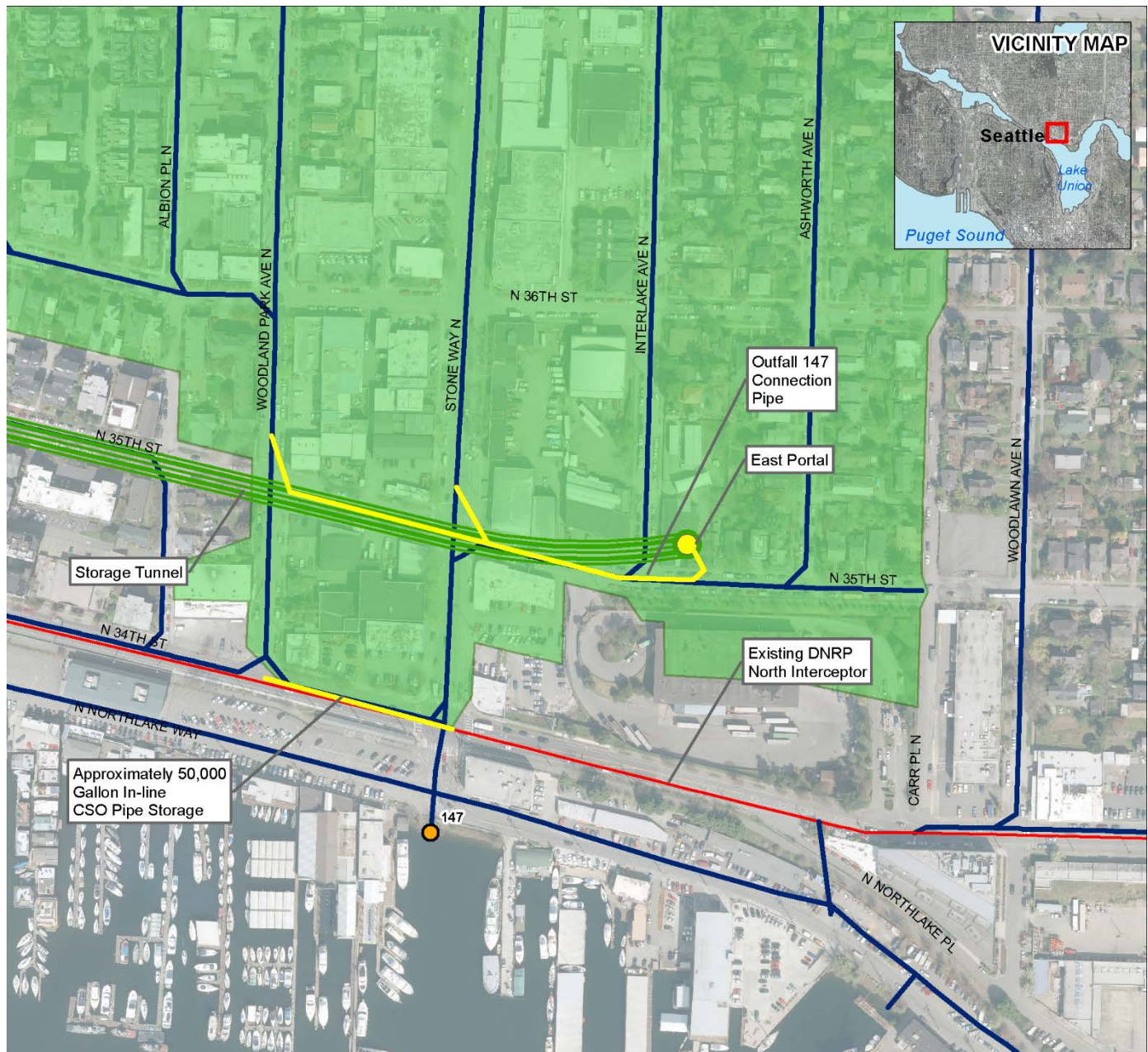
Seattle
Public
Utilities

Ship Canal Water Quality Project Final Facility Plan

North 3rd Avenue/174 Drop
Shaft and Conveyance Area

March 2017

Figure 1-7



Note: System shown is conceptual and subject to changes/additions/deletions during final design phase.

LEGEND

- SPU CSO Outfall
- Ship Canal Tunnel
- SPU Basin 147 (Wallingford)
- New conveyance piping and structures
- DNRP combined sewer mainline
- SPU combined sewer system

Seattle
Public
Utilities

Ship Canal Water Quality Project Final Facility Plan

East Portal and Basin 147 Conveyance Area

March 2017

Figure 1-8

This page intentionally left blank.

2 Contact Information

The owner of this project is Seattle Public Utilities. The owner's representative is listed as follows:

Madeline Fong Goddard, P.E.
Deputy Director
Drainage and Wastewater Line of Business
Seattle Public Utilities
700 Fifth Avenue, Suite 4900
P.O. Box 34018
Seattle, WA 98124-4018
madeline.goddard@seattle.gov
(206) 733-9191

This page intentionally left blank.

3 Facility Plan Overview and Background

This Facility Plan outlines improvements to the SPU and DNRP combined sewer system that are necessary to reduce SPU and DNRP Ship Canal WQ Project area CSOs to a 20-year moving average of no more than one untreated discharge per year per outfall. This Facility Plan meets the requirements of WAC 173-240-060 (Engineering Reports), WAC 173-245 (Submission of Plans and Reports for Construction and Operation of Combined Sewer Overflow Reduction Facilities), and the engineering report requirements included in both agencies' CSO Consent Decrees. A Facility Plan is being substituted for an Engineering Report, and it includes additional content, beyond an Engineering Report, that is necessary when an agency is applying for state or federal funding.

This chapter describes the document organization and provides background information on the CSOs and sewers in the Ship Canal WQ Project basins, including problem identification, CSO control and storage volumes, sewer system classifications, previous CSO reduction efforts, and the related regulatory framework for the project.

3.1 Document Organization

This Facility Plan is organized as follows:

- **Chapter 1 – Executive Summary:** Provides background information on CSOs in the Ship Canal WQ Project basins, discusses the alternative development and evaluation process completed in the *Plan to Protect Seattle's Waterways* (SPU, 2015a) and refined in the Facility Plan, and explains how SPU and DNRP evaluated the recommended alternative.
- **Chapter 2 – Contact Information:** Documents the contact information for the authorized owner's representative.
- **Chapter 3 – Project Overview and Background:** Provides background information on SPU and DNRP CSOs in the Ship Canal WQ Project basins, including problem identification, CSO control and storage volumes, sewer system classifications, previous CSO reduction efforts, and the related regulatory framework.
- **Chapter 4 – Existing Environment:** Describes the existing environmental conditions, including earth and groundwater; surface water; air quality and odors; fisheries and biological resources; land and shoreline use and visual quality;

recreation; transportation; noise and vibration; energy and climate change; and historical, cultural and archaeological resources.

- **Chapter 5 – Existing Conditions:** Describes the existing sewer system in the Ship Canal WQ Project basins including the combined sewer basins and flow routing, the DNRP North Interceptor, other existing DNRP facilities and pipelines, existing CSO facilities in operation by both agencies, and the SPU and DNRP CSO outfalls.
- **Chapter 6 – Historical Combined Sewer System Flows:** Summarizes the historical flows from the Ship Canal WQ Project basins based on monitoring of actual CSO events and describes the CSO control volumes calculated using a hydraulic sewer model.
- **Chapter 7 – Future Conditions:** Describes the projected future conditions in the Ship Canal WQ Project basins related to land use, sewer flows, and other issues.
- **Chapter 8 – Options Development and Evaluation:** Summarizes the process that SPU and DNRP used to develop and evaluate potential solutions to reduce the CSO frequency and volume in the Ship Canal WQ Project basins. This chapter also discusses CSO control options and screening of the CSO control options completed as part of the SPU LTCP (Volume 2 of the *Plan to Protect Seattle's Waterways* [SPU, 2015a]) and King County CSO Control Plan Amendment (King County, 2012a). These plans developed Ship Canal WQ Project basin-specific options, and evaluated the options using a TBL approach to determine the highest-ranking option.
- **Chapter 9 – Evaluation of Highest-Ranking Options:** Provides detailed engineering, cost, and environmental information for the highest-ranking CSO control option for the Ship Canal WQ Project basins.
- **Chapter 10 – Recommended Option:** Provides detailed engineering, cost, and environmental information for the recommended option. This chapter also identifies new or changed elements of the project that were not described in the *Plan to Protect Seattle's Waterways* Volume 2, LTCP (SPU, 2015a), and Volume 4, Final Plan Environmental Impact Statement (EIS; SPU, 2014b).
- **Chapter 11 – Financial Analysis:** Includes financial information related to the recommended options and describes the various components of the project costs, including construction costs, total costs, and O&M costs. This chapter also discusses how SPU finances capital projects and describes SPU's managerial capability.
- **Chapter 12 – Other Topics:** Documents the relevance of the Ship Canal WQ Project to various city, state, and federal environmental regulations. Relevant state regulations include the State Environmental Policy Act (SEPA) and the Growth Management Act (GMA). The federal regulations discussed relate to historic preservation, air quality, water resources, fish and wildlife, and farmland.

- **Chapter 13 – References:** Lists the documents and other sources of information used as part of the development of this Facility Plan.

This Facility Plan will serve as the conceptual basis for detailed design activities associated with the Ship Canal WQ Project. This plan also satisfies the associated Consent Decree milestones for Facility Plan submissions of King County CSO control projects for the 3rd Avenue W and 11th Avenue NW CSO basins.

3.2 Problem Identification

The Ship Canal WQ Project area encompasses CSO basins located to the north and south of Salmon Bay, the Ship Canal, and Lake Union. These waterbodies form the southern boundary of the northern basins. The northern boundary is generally formed by NW 85th Street, Leary Way NW, and N 36th Street. The western and eastern boundaries of the CSO basins located north of the Ship Canal are the Ballard neighborhood to the west and Wallingford neighborhood to the east.

A separate location south of Salmon Bay and the Ship Canal is included in the project area to make a connection and improve the existing DNRP system. This location includes the drop structure and new conveyance for 3rd Avenue W on the south side of the Ship Canal.

The Ship Canal WQ Project basins currently include the following:

- SPU system:
 - Basins 147, 150/151, 152, and 174
 - CSO Pump Station 84
 - More than 311,000 feet of sanitary and combined sewer pipe with diameters ranging from 6 inches to 54 inches
 - More than 1,390 maintenance holes
 - Overflow structures 147A, 147B, 150/151, 152, and 174
 - Outfalls 147, 150, 151, 152, and 174
- DNRP system:
 - 3rd Avenue W and 11th Avenue NW basins
 - Approximately 23,200 feet of sanitary and combined sewer pipe with diameters ranging from 24 inches to 116 inches
 - Approximately 60 maintenance holes
 - 3rd Avenue W Overflow Structure, 11th Avenue NW Overflow Structure, Ballard Regulator Station, Fremont Siphon, and Ballard Siphon

- 3rd Avenue W Outfall (DSN-008) and 11th Avenue NW Outfall (DSN-004)

Portions of the Ship Canal WQ Project basins have partially separated sewer systems, where stormwater from private property (for example, roof drains) typically enters the sanitary sewer system, while stormwater from public property (for example, streets) typically enters a separate drainage system. For partially separated systems, under wet-weather conditions, flows are a combination of sewage and stormwater. As long as the flows are within the capacity of the sewer system, the pipes convey all flows to the West Point Treatment Plant. However, if the flows exceed the capacity of the sewer system, then the excess volume of sewage and stormwater discharges into receiving water bodies through outfalls. Six basins (SPU Basins 147, 150/151, 152, and 174, and DNRP Basins 3rd Avenue W and 11th Avenue NW) and their respective seven CSO outfalls (Outfalls 147, 150, 151, 152, 174, 3rd Avenue W, and 11th Avenue NW) exceed a 20-year moving average of one untreated discharge per year and are the focus of the improvements described in this Facility Plan. Section 3.4 describes CSOs in more detail.

The following regulatory requirements limit SPU and DNRP's CSOs to no more than one untreated discharge per year per outfall over a 20-year moving average:

- RCW 90.48.480—This law requires “the greatest reasonable reduction of combined sewer overflows.”
- WAC 173-245-020 (22)—“The greatest reasonable reduction’ means control of each CSO in such a way that an average of one untreated discharge may occur per year.”
- The City of Seattle's and King County's NPDES permits and Consent Decrees.

3.3 Combined Sewer Overflow Control and Storage Volume

Understanding the following two key terms related to the volume requirements is important:

- **Control volume**—The amount of excess combined sewage that must be captured or intercepted before the outfall such that a 20-year moving average of no more than one untreated discharge per year per outfall is achieved.
- **Storage volume**—The actual size of the facility that needs to be constructed to operate and meet the control volume requirement for all CSO basins being controlled under various conditions.

The storage volume is not necessarily the same as the CSO control volume because the storage volume depends on additional factors, including the following: 1) system hydraulics, 2) storage location, 3) control system, and 4) timing of the release of stored volumes to avoid impacts to downstream facilities.

The approach used to establish the CSO control volume and peak flow rates for the Ship Canal WQ Project basins is approximate and based on the best available data and analysis methods over a simulation using 32 years of rainfall data. The CSO control volumes for SPU Basins 147, 150/151, 152, and 174 were determined using the EPA Storm Water Management Model (SWMM) 5 model. The hydrologic portion (surface runoff and local system flows) of the balance of DNRP's 3rd Avenue W basin (above Fremont and Wallingford flows) and the 11th Avenue NW basin were modeled with a runoff/transport model; the hydraulic components (DNRP trunks and interceptor flow) of the system were modeled using UNSTDY (SPU, 2015a; King County, 2012a).

For more information about the modeling results and monitoring effort of the individual basins, refer to Chapter 6 of this report and *Long-Term Control Plan Hydraulic Model Report, Volume 2: Ballard* (SPU, 2012b); *Long-Term Control Plan Hydraulic Model Report, Volume 5: Fremont/Wallingford* (SPU, 2012c); and the King County CSO Control Plan Amendment (King County, 2012a).

The ability of the tunnel as sized to meet the CSO compliance requirement of no more than one overflow per outfall per year on a 20-year moving average was confirmed by modeling results as summarized in Appendices G and L of SPU's Final LTCP (SPU, 2015a). SPU is developing new basin models using the MIKE URBAN modeling platform. DNRP is developing a new interceptor model using the MIKE URBAN modeling platform that will incorporate the no impact release rates (NIRRs). These models will be used in detailed design to confirm storage volume requirements to meet the performance standard of no more than one overflow per outfall per year on a 20-year moving average and to assure that there are no downstream impacts on the DNRP system.

The CSO control volumes for SPU and DNRP combined sewer basins include allowances for climate change. Neither SPU nor DNRP CSO control volumes include allowances for increases in sewage or stormwater runoff from new development or redevelopment.

Based on the fully developed nature of the Ship Canal WQ Project area, substantial increases in flows resulting from development are unlikely. The City of Seattle Department of Construction and Inspections does not plan to change any zoning in the area, but infill and redevelopment could occur. Redevelopment could increase impervious area, but overall redevelopment would likely reduce wet-weather inflows to the combined sewer system. Future improvements would trigger a provision in the City's Stormwater Code, which requires more restrictive controls of stormwater runoff or requires that the runoff divert to existing or potentially future new storm drains instead of to the combined sewers, or both.

3.4 Sewer Classifications and Related Combined Sewer Overflow Impacts

The following three types of sewer systems are in the Ship Canal WQ Project basins: combined, separated, and partially separated. These are described in this section.

3.4.1 Combined Sewer System

Combined sewer systems convey both sewage and stormwater in the same pipes. Homes and businesses generate sewage. Stormwater runoff is generated from sources such as streets, parking lots, roof drains, and foundation drains.

Under dry-weather conditions, combined sewer systems convey primarily sewage to the wastewater treatment plant. Treated effluent flows from the wastewater treatment plant into receiving water bodies.

Under wet-weather conditions, flows are a combination of sewage and stormwater. All sewage and stormwater flows are conveyed to the treatment plant as long as the flow volumes are within the capacity of the sewer system. If the flow volumes exceed the capacity of the sewer system, then the excess sewage and stormwater discharges into receiving water bodies through permitted outfalls; this discharge is called CSO.

3.4.2 Separated Sewer Systems

Fully separated sewer systems convey sewage and stormwater in two distinct systems: a sanitary sewer system and a drainage system. The sanitary sewer system primarily collects sewage and conveys it to a treatment plant. The drainage system collects only stormwater and conveys it directly to local water bodies or, in some cases, partially treats it and then sends it to local water bodies.

Separated systems have the advantage of predictable and relatively stable flows. However, separated systems have the disadvantage that, without treatment, any contaminants in the stormwater system will discharge directly to local water bodies. In some cases, stormwater treatment is added to the drainage system to reduce the contaminants discharged. Examples of stormwater treatment commonly used by SPU and DNRP include roadside treatment bioswales and treatment vaults that remove pollutants from runoff generated by paved surfaces.

3.4.3 Partially Separated Sewer Systems

Partially separated sewer systems are hybrid systems wherein one system handles sewage and some stormwater flows, while another system conveys stormwater flows separately. In Seattle, the distinction between the two systems is generally a distinction between private and public property. Stormwater from private property (such as roof

drains and private parking lots) typically drains to the combined sewers where, if there is sufficient pipe capacity, the combined stormwater and sewage is conveyed to the treatment plant. Stormwater from public property (such as streets and public rights-of-way) typically drains to separate storm drains that convey the stormwater to outfalls that discharge into receiving water bodies.

3.5 Regional Combined Sewer Overflow Reduction Efforts

Efforts to reduce CSOs in the Puget Sound area have been under way since as early as the 1950s. In 1958, Metro was formed to clean up the waters of Lake Washington and the City of Seattle waterfront. In 1961, Metro assumed ownership of wastewater treatment facilities from the City of Seattle (Seattle Municipal Archives, 2015). In 1994, King County assumed Metro's responsibilities for regional wastewater management (King County, 2012a).

The City of Seattle Engineering Department designed and constructed and the Department of Streets and Sewers operated and maintained the City's drainage and sewage infrastructure from 1896 to 1936. The Engineering Department assumed sole management from 1936 to 1997, including wastewater treatment facilities until 1961 (transferred to Metro). SPU was formed in 1997 and continues to be the sole manager for the City-owned wastewater infrastructure. Following are key milestones in the Seattle region's CSO reduction efforts:

- **1950s—The City of Seattle started installing separated sewer systems:** Originally, the sewer system was a CSS. The City designed and constructed additions to the sewer system as separated systems.
- **1958—Metro is formed:** Metro is formed as a regional wastewater agency to clean up the waters of Lake Washington and the City of Seattle waterfront.
- **1960s—The City of Seattle began partial separation of combined sewer systems:** The City's original combined sewer system conveys both stormwater and sewage. The City designed separated systems to diverted stormwater from public property (such as streets and rights-of-way) into separate pipelines, while leaving stormwater from private property (such as roof drains and private parking lots) connected to the combined sewer system. The City converted half of its combined sewer system to a partially separated system. An estimated 70 percent of the total stormwater runoff has been removed from the combined sewer system.
- **1961—Wastewater treatment responsibility is transferred to Metro:** The City of Seattle transferred wastewater treatment facility ownership and operations to Metro. Metro began to address regional water quality by reducing untreated sewage discharges to the environment.

- **1979—Metro adopted its first CSO Control Plan (Metro, 1979):** This plan was developed in response to the federal Clean Water Act of 1972 (CWA). Before projects in the program were fully implemented, Metro decided to integrate CSO control planning into a larger system-wide planning effort that was launched to meet new secondary treatment regulations.
- **1980s—Metro began providing storage:** Metro started to design and construct storage and subsequent controlled release of storm-induced combined flows to reduce impacts to treatment plants.
- **1980—Metro prepared the *201 Facilities Plan* (Metro, 1980):** This plan focused on CSO control in high-priority areas (Longfellow Creek, Lake Washington, and Puget Sound beaches) based on human contact potential and environmental protection.
- **1985 and 1986—Metro prepared *Plan for Combined Sewer Overflow Control* (Metro, 1985) and the *Supplemental Plan for Combined Sewer Overflow Control* (Metro, 1986):** These plans integrated the Metro CSO control plan into a system wide planning effort.
- **1988—The City prepared the *Comprehensive Combined Sewer Overflow Control Plan* (City of Seattle, 1988):** This plan addressed CSO reduction in Portage Bay, Lake Union, the Ship Canal, Elliott Bay, and the Duwamish River.
- **1988—Metro prepared the *Final 1988 Combined Sewer Overflow Control Plan* (Metro, 1988):** This plan responded to new Ecology regulations established in 1987.
- **1990s—The City began monitoring CSO control structures:** The City installed overflow monitors at the regulated CSO outfalls discharging to Portage Bay, Lake Union, the Ship Canal, Elliott Bay, and the Duwamish River.
- **1995—Metro prepared the *Combined Sewer Overflow Control Plan 1995 Update* (Metro, 1995):** The report served as the 1995 update to the *1988 Combined Sewer Overflow Control Plan*.
- **1998- King County prepared the *Regional Wastewater Services Plan* (King County, 1998):** The Regional Wastewater Services Plan (RWSP) outlined wastewater projects to implement over the next 30 years to, serve population growth, and meet regulatory requirements (protect human health and the environment). The RWSP was identified as the County's new CSO Control Plan.
- **1999—King County prepared the *1999 Combined Sewer Overflow Control Plan Amendment* (King County, 1999a):** This plan listed 21 CSO control projects to bring all CSOs into control by 2030.
- **2000—SPU completed installation of CSO monitors:** SPU installed overflow monitors at the remaining regulated CSO outfalls, including the locations where CSO pump stations could overflow.

- **2000—King County prepared the *Combined Sewer Overflow Control Plan Year 2000 Update (King County, 2000)*:** The report served as the 2000 update to the 1995 plan and updated the 1998 RWSP.
- **2001—SPU prepared the *CSO Reduction Plan Amendment (SPU, 2001)*:** The amendment identified six additional high-priority areas for CSO reduction. The amendment emphasized the “Nine Minimum Controls” established by the EPA and system retrofit projects. SPU identified storage volumes necessary to limit CSOs to a 20-year moving average of no more than one untreated discharge per year per outfall. The amendment also reevaluated combined sewer areas and expanded the evaluation to include other combined sewer areas. SPU recommended storage and best management practices (BMPs) for 26 combined sewer basins deemed highest priority.
- **2002—SPU began implementing the CSO Retrofit Program:** SPU initiated a CSO retrofit program designed to improve the efficiency of the existing combined sewer system and to assist in reducing the frequency and volume of CSOs. Potential projects were identified that were relatively low-cost and easy to implement, such as adjustments of overflow weir heights to use more existing system storage and reduce CSOs.
- **2005—SPU prepared the *CSO Reduction Plan Amendment 2005 Update (SPU, 2005)*:** SPU evaluated the effectiveness of BMP and retrofit projects identified by the *2001 CSO Reduction Plan Amendment (SPU, 2001)*. SPU revised cost estimates and schedules for remaining, uncompleted projects to better coincide with King County’s CSO reduction schedule.
- **2008—King County updated its CSO Control Plan (King County, 2008):** King County updated the CSO Control Plan with updated flow projections as part of the West Point Treatment Plant NPDES permit renewal process.
- **2010—SPU prepared the *2010 CSO Reduction Plan Amendment (SPU, 2010a)*:** The City focused on efforts through 2015 to reduce CSOs at the most critical sites through a cost-effective blend of traditional and sustainable infrastructure in a four-part approach:
 1. Optimize existing CSO infrastructure through low cost retrofits.
 2. Construct large CSO infrastructure projects to reduce overflows to Lake Washington.
 3. Construct natural “green” solutions to reduce CSOs throughout the city.
 4. Develop a long-term plan to control all remaining CSOs and achieve water quality goals.

- **2012—King County prepared the *2012 King County Long-Term Combined Sewer Overflow Control Plan Amendment (King County, 2012a)*:** This amendment updated the CSO Control Program priorities, assumptions, and other factors shaping control needs and recommended an amendment to King County's Plan to meet current conditions. The goal was to select CSO control alternatives that optimize and balance environmental, social, and financial goals to meet current needs, while protecting future opportunities.
- **2013 (July 3)—Consent Decrees filed in the U.S. District Court for the City of Seattle and King County:** King County's Consent Decree requires constructing and implementing the CSO control measures described in the approved King County LTCP in accordance with milestone completion dates outlined in the Implement Only consent decree. The City's Consent Decree required developing and implementing its LTCP and Post-Construction Monitoring Plan (PCMP) in accordance with milestone completion dates outlined in the decree, and provided an option to submit an Integrated Plan (United States of America, 2013a and 2013b).
- **2015—SPU prepared the *Plan to Protect Seattle's Waterways (SPU, 2015a)*:** This four-volume plan includes Volume 1 – Executive Summary, Volume 2 – Long Term Control Plan, Volume 3 – Integrated Plan, and Volume 4 – Final Plan Environmental Impact Statement. The plan documents Seattle's strategy for meeting the requirements of its Consent Decree.
- **2015—SPU prepared the *Final CSO Post-Construction Monitoring Plan (SPU, 2015b)* in accordance with the City's Consent Decree:** The Final PCMP includes updated analysis and revision of surrogate CSO outfall sampling locations using 2010-2014 monitoring data and an implementation schedule based on milestone compliance dates in the *Final Plan to Protect Seattle's Waterways (SPU, 2015a)*. In addition to meeting the one overflow per outfall per year on a moving 20-year average, the completed CSO control measure must also meet water quality standards, protect designated uses, and require verification by post-construction monitoring (frequency of overflow and sediment sampling to show compliance with sediment standards).

The CSO control volume from SPU facilities has declined from an estimated 400 MG per year in the 1980s to an average of approximately 115 MG per year from 2010 to 2014. Similarly, overflow frequency has declined from an estimated 2,800 events per year in the 1980s to an average of approximately 316 events per year, based on overflow data from 2010 to 2014. This frequency reduction of almost 90 percent is substantial but does not achieve a 20-year moving average of no more than one untreated discharge per year per outfall.

The modeled baseline for DNRP's system suggests that projects implemented to directly or indirectly achieve CSO control have reduced the CSO volume from 2,339 MG per year (1981-1983 for Ecology planning) over a frequency of 471 CSO events, to 808 MG per year over a frequency of 353 CSO events in 2010. This would be a 65-percent reduction in CSO volume since the 1980s (King County, 2012a).

3.6 Regulatory Framework

3.6.1 Clean Water Act and National Pollutant Discharge Elimination System Permits

The Federal CWA (33 United States Code [U.S.C.] §1251 et seq.) requires express authorization for the discharge of any pollutant from a point source into navigable waters of the United States. This is a broad requirement, insofar as the term "point source" is defined as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, or conduit" (33 U.S.C. §1362[14]). Similarly, the term "pollutant" is broadly defined to include "dredged spoil, solid waste, sewage, garbage, sewage sludge, chemical wastes, biological materials, heat, rock, sand" and other materials (33 U.S.C. §1362[6]).

To meet this discharge authorization requirement, the CWA established the NPDES program. The purpose of the NPDES is to limit the discharge of pollutants to meet water quality criteria. In Washington State, Ecology was delegated authority to administer the NPDES program. Ecology's regulations in WAC Chapter 173-220 govern individual NPDES permits, such as SPU's and DNRP's CSO permits.

3.6.2 U.S. Environmental Protection Agency Combined Sewer Overflow Control Policy of 1994

The CWA described in 33 U.S.C. §1342(q)(1) requires that any permit issued to authorize discharges from a CSO must conform to the EPA CSO Control Policy of April 11, 1994 (59 *Federal Register* 18688-18698).

EPA's CSO Control Policy is the national framework for controlling CSOs. The policy provides guidance on how communities with combined sewer systems can meet CWA goals in as flexible and cost-effective a manner as possible.

The policy has the following three main elements:

- Nine Minimum Controls
- Long-term Control Plans
- Requirement to meet Water Quality Standards

The Nine Minimum Controls (EPA, 1995) listed below are measures that can reduce the prevalence and impacts of CSOs. Both SPU and DNRP are required to demonstrate that they are undertaking all Nine Minimum Controls as part of their respective NPDES permits. The Nine Minimum Controls include the following measures:

- Proper O&M
- Maximum Use of Collection System for Storage
- Review and Modify Pretreatment Requirements
- Maximize Flow to the Treatment Facility
- Eliminate Dry-Weather Overflows
- Control of Solid and Floatable Materials in CSOs
- Pollution Prevention
- Public Notification Regarding CSO Occurrences and Impacts
- Monitoring to Characterize CSO Impacts and Efficacy of CSO Controls

Long-Term Control Plans are tools to assist with compliance with the CWA and include the following elements:

- Characterization, monitoring, and modeling of the combined sewer system
- Public participation
- Consideration of environmentally sensitive areas
- Evaluation of alternatives to meet CWA requirements using either the "presumption approach" or the "demonstration approach"
- Cost and performance considerations
- Operational plan
- Maximizing of treatment at the existing treatment plant
- Implementation schedule
- Post-construction compliance monitoring program

3.6.3 Washington State Law, National Pollutant Discharge Elimination System Permits, and Consent Decrees

The CWA at 33 U.S.C. §1370 allows for states to adopt pollution-control standards and requirements, as long as they are at least as stringent as the standards and requirements in CWA 33 U.S.C. §1251 et seq. In Washington, state CSO control law (RCW 90.48.480) predates EPA's CSO Control Policy and requires local governments to develop reasonable plans and compliance schedules to achieve the "greatest

reasonable reduction” of CSOs at the earliest possible date. State regulations indicate that “the greatest reasonable reduction” means control of each permitted CSO outfall in such a way that no more than one untreated discharge may occur per year (WAC 173-245-020 [22]). The City and King County Consent Decrees require SPU and DNRP to use a 20-year moving average to assess compliance.

CSO reduction plans must, at a minimum, document CSO activity, analyze control and treatment alternatives, analyze selected treatment and control projects, develop priority rankings, and implement a schedule. Permittees must submit an amendment to their CSO plan with each application for NPDES permit renewal.

Ecology first issued the City an NPDES permit for CSO discharges in 1975. Ecology has reissued the permit periodically, most recently as NPDES Permit WA0031682 issued March 30, 2016, with an effective date of May 1, 2016. The permit requires implementing the EPA Nine Minimum Controls (see Section 3.6.2), defines monitoring requirements, establishes requirements for detailed reporting to Ecology, and authorizes only discharges that result from precipitation events. This permit also requires an annual report.

The DNRP CSO treatment plants are covered under the West Point Treatment Plant NPDES permit (WA0029181), which was renewed on December 19, 2014, and became effective on February 1, 2015. The permit provides coverage for secondary treatment and CSO discharges at West Point Treatment Plant, four CSO treatment facilities (Alki, Carkeek, Elliott West, and Henderson/MLK), and 38 CSO outfalls. For the West Point Treatment Plant, the permit requires secondary treatment for most flow through the plant and provides limited authorization to bypass a portion of the flow around secondary treatment during wet-weather events when flows exceed the facility’s secondary treatment capacity. The permit requires primary treatment and disinfection at the four CSO treatment facilities. The permit also provides limited authority to discharge untreated combined sewage from the 38 CSO outfalls.

On July 3, 2013, the U.S. District Court for the Western District of Washington approved Final and Fully Executed Consent Decrees for the City and King County. The Consent Decrees are legal agreements entered into by the EPA, Ecology, DOJ, and the City and King County, respectively, to provide certainty to each agency regarding regulatory requirements, provide adequate time to reach compliance, and avoid the risk of long and costly litigation. King County chose to negotiate a settlement in which their 2012 CSO Control Plan Amendment was the basis of the Implement Only Consent Decree that includes a specific list of projects and critical milestones.

The City’s approved *Plan to Protect Seattle’s Waterways* (SPU, 2015a) allows deferral of six specific lower-priority City CSO control projects until 2030 in exchange for completing

specific higher-priority stormwater projects by 2025. All other City CSO control projects must be completed by 2025. King County's Consent Decree requires completing all King County CSO control measures by 2030. Both Consent Decrees establish enforcement mechanisms that ensure each agency's critical milestones are met.

King County's Consent Decree included individual projects and project milestone dates for controlling the 11th Avenue NW and 3rd Avenue W combined sewer basins.

King County's participation as a partner with SPU on the Ship Canal Project has been approved and documented by modification to its Consent Decree with DOJ, EPA, and Ecology, filed October 25, 2016, with the United States District Court, Western District of Washington (United States of America, 2016).

4 Existing Environment

This chapter describes the existing environmental conditions including earth and groundwater; surface water; air quality and odors; fisheries and biological resources; land and shoreline use and visual quality; recreation; transportation; noise and vibration; energy and climate change; and cultural resources.

The affected environment described in Section 4.1 of the 2014 Plan EIS (SPU, 2014b) has not materially changed. A supplemental EIS (SEIS) was prepared to provide additional environmental analysis to supplement the 2014 Plan EIS. The SEIS (SPU, 2017) focuses on changes and additions to the Ship Canal WQ Project scope and analysis included in the 2014 Plan EIS.

4.1 Earth and Groundwater

4.1.1 Earth

After the 2014 Plan EIS was issued (SPU, 2014b), geotechnical investigations were completed for the tunnel to provide additional information on the regional geologic and hydrogeologic setting and anticipated subsurface conditions specific to the Ship Canal WQ Project. This information is provided in the Draft Geotechnical Data Report (GDR; Shannon & Wilson, 2015a). The project-specific geotechnical information will be updated as new information is obtained from ongoing geotechnical investigations. A preliminary Geotechnical Assessment Report (GAR) was also prepared based on geotechnical investigations completed to date, associated field and laboratory testing, and expertise on similar projects (Shannon & Wilson, 2015b). The report provides preliminary geotechnical design criteria for construction.

An environmental risk corridor analysis was conducted along the proposed tunnel alignment to assess the risk of contaminated materials within a quarter mile of the project corridor that could pose risks to earth and groundwater. Because tunnel depths extend at least 50 feet below ground surface for most of the project footprint, there is a very low likelihood of contamination reaching that depth. The analysis identified potential for encountering some contaminated materials at excavations near the ground surface, such as the portals and drop structure shafts. Construction areas that are found to be contaminated will be remediated in advance of tunnel construction; contaminated soils will be disposed of in accordance with applicable requirements.

Three soil groups are expected to be present along the tunnel alignment: till and till-like deposits, cohesionless sand and gravel, and cohesive silt and clay. These soils are

expected to have similar engineering properties and anticipated ground behavior (Shannon & Wilson, 2015b). These soil types are found throughout the region and are generally favorable soils for tunneling.

4.1.2 Groundwater

Groundwater within the project area, with a few exceptions, is generally 10 to 30 feet below the ground surface. An exception is near the East Portal, where groundwater is near the ground surface or above (artesian groundwater conditions). Additional groundwater monitoring in the project area is ongoing and the GAR (Shannon & Wilson, 2015b) will be updated as the information is obtained to inform design criteria and construction methodology.

4.1.3 Contamination

The environmental risk corridor analysis completed for the Ship Canal WQ Project identifies 13 properties along the tunnel alignment and within construction areas that have known or suspected contamination. Four types of known or suspected contaminants have been identified on these properties:

- Petroleum hydrocarbons (oil and gasoline)
- Heavy metals (such as arsenic, chromium, lead, and mercury)
- Dry cleaning and degreasing solvents (such as trichloroethylene and tetrachloroethylene)
- Asbestos

Most contaminants typically accumulate within the first 15 feet of the ground surface. Along the deep tunnel alignment, most contaminants would not reach the depths of the tunneling activity because the contaminants are not mobile in the subsurface soils, or are less dense than water, and therefore would not sink through saturated soils. The most notable exceptions are dry cleaning solvents (tetrachloroethylene) and chlorinated degreasing solvents used in automobile repair.

Much of the project area is zoned for industrial or commercial use (see Figure 4-1). Of the 13 properties identified, one property is near the West Portal, 11 are along the tunnel alignment, and one is near the East Portal. The Salmon Bay Hotel Group property, a former plating shop at 5300 24th Avenue NW near the West Portal, was investigated in 2010 and in 2015; soil and groundwater contamination with petroleum, metals, and chlorinated solvents was documented (Riley & Associates, 2010; Gladstone Enterprises, LLC, 2015). The 11 sites along the tunnel alignment include historical dry cleaning operations, automotive repair shops, fuel depot, auto wrecking yards, paint store, print shop, and former industrial site. The property near the East Portal is a former

government storage site and commercial building; it was also used by the City of Seattle as an interim fire station. The structure was demolished in 2015 by others (not related to the Ship Canal WQ Project). The demolition was accomplished in accordance with city, state, and federal regulations. Based on the age of the building, there may have been asbestos, lead-based paint, and mercury in the building materials. All debris from the demolition was removed from the site.

4.2 Surface Water

Surface water resources in the project area are the Ship Canal, and a portion of Lake Union. Sources of pollutants that affect these water bodies include discharges from industrial facilities, CSOs, spills, contaminated groundwater, urban stormwater runoff, and saltwater intrusion.

4.2.1 Ship Canal

The Ship Canal includes the interconnected waterways of the Hiram M. Chittenden Locks (also known as the Ballard Locks), Salmon Bay, Salmon Bay Waterway, and Fremont Cut. The project area is located within and adjacent to the Ship Canal, and the project area drains to the Ship Canal. Water quality of the Ship Canal is influenced by freshwater flows coming from Lake Washington and from storm drains and CSOs. The Ship Canal WQ Project addresses overflows from seven permitted, currently “uncontrolled” CSO outfalls. Three of these outfalls (SPU Outfall 174 and DNRP’s 3rd Avenue W and 11th Avenue NW CSO outfalls) overflow to the Ship Canal. Elevated concentrations of some chemicals are present in the sediments near CSO outfalls, including outfalls in the Ship Canal.

Water quality in the Ship Canal is generally good and meets most current Washington State standards. However, baseline water quality in the Ship Canal is affected by localized sources of pollutants. The Washington State Department of Ecology has listed some areas as impaired (Category 5) under the current EPA-approved 2015 303(d) listing (Ecology, 2015a). The Ship Canal currently exceeds criteria for both temperature and bacteria. The bacteria criterion was exceeded in 2005, 2007, and 2010. Preparation of a cleanup plan is required for Category 5 listings.

Salmon Bay is a narrow body of water linking Lake Washington to Puget Sound through the Ballard Locks. It is the westernmost section of the Ship Canal and empties into Shilshole Bay in Puget Sound. Because of the input from the Locks, the western half of Salmon Bay is dominated by salt water, and the eastern half is predominantly freshwater. Salt water can contribute to low dissolved oxygen and other water quality issues. Three of the seven permitted outfalls in the project area overflow to Salmon Bay: Outfalls 150, 151, and 152.

Water quality in Salmon Bay has been affected by nearshore sediment quality, which has been degraded by urban development. The numerous industries, marinas, dock facilities, and combined sewer and stormwater discharges have contributed to contamination of Salmon Bay sediments with metals, petroleum products and byproducts, polychlorinated biphenyls, and other organic compounds. Sediment samples in this area have exceeded the sediment quality standards for several metals and organic compounds, including areas near the proposed dock replacement site (Cubbage, 1992).

Salmon Bay is included on the EPA-approved 2015 303(d) listing as Category 5 (impaired) for lead, pH, Aldrin, and bacteria. This bay is also listed as a Category 4C (impaired by a nonpollutant) for invasive exotic species and Category 2 (water of concern) for temperature, dissolved oxygen, dichlorodiphenyltrichloroethane (DDT) isomers, and zinc.

4.2.2 Lake Union

The Lake Union Ship Canal system serves as a transitional zone between Lake Washington and Puget Sound. SPU Outfall 147, one of the seven permitted outfalls in the project area, overflows to Lake Union. In general, water quality in Lake Union has improved since the 1960s as wastewater discharges have been eliminated and industries have reduced or eliminated practices that result in contamination. However, Lake Union still has water quality issues, including low dissolved oxygen conditions during certain times of the year. Lake Union is part of the Ship Canal and thus, has the same 303(d) listing as described above for the Ship Canal.

4.2.3 Floodplains

No identified floodplains are within the Ship Canal WQ Project area.

4.3 Air Quality and Odors

4.3.1 General Air Quality Conditions

The EPA has set federal standards for the following six "criteria air pollutants:" fine and coarse particulate matter, ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead. In the Puget Sound area, the Puget Sound Clean Air Agency, along with Ecology, monitors and regulates levels of criteria air pollutants.

The Puget Sound Clean Air Agency releases an annual report documenting and analyzing air quality data. The most recent report was published in July 2014 and covers data from 1990 to 2014. One of the key sets of data in the report is the Air Quality Index, which is a nationwide reporting standard developed by EPA for the criteria air pollutants.

The Air Quality Index is used to report daily air quality and category days as (1) good, (2) moderate, (3) unhealthy for sensitive groups, or 4) unhealthy. The 2014 Air Quality Index ratings for King County rated 72.3 percent of the days as good, 27.1 percent of the days as moderate, and 0.5 percent of the days as unhealthy for sensitive groups (Puget Sound Clean Air Agency, 2014).

Air quality in King County is generally good. However, King County is designated as a maintenance area for carbon monoxide, ozone, and particulate matter. Ecology tracks air quality at monitoring sites across Washington. The nearest air quality monitoring site to the project area is south of downtown Seattle at 10th and Weller (Ecology, 2015b).

4.3.2 Odor Conditions

Within the past ten years, the following odor complaints in the project area were registered with DNRP:

- 8/1/2012 and 8/16/2012: two odor complaints at 3rd Avenue NW and Nickerson Street near the Fremont Siphon, where odors were from a few nearby manholes.
- 12/1/2009, 4/2009-5/2009: five odor complaints from homeowner at 142 NW Canal Street near the Fremont Siphon forebay. After a thorough investigation, DNRP determined that the home had internal plumbing problems and DNRP's wastewater system was not the cause of odors.
- 11/16/2005: ongoing odor problem on NW 50th Street where the 8th Avenue Interceptor connects to the Ballard Trunk, resulting in odors emanating from a vent pipe.

SPU has set a general goal of limiting system wide odor complaints to less than 30 per year. Since 1990, the annual number of odor complaints resulting in odor abatement action has been at or below 30. SPU's and DNRP's standard policy is to investigate all odor complaints, implement measures to eliminate problems as they arise, and proactively clean and maintain the sewers.

Odor problems are addressed by either preventing the occurrence of odorous gases or treating the gas after it forms. Prevention can include injecting various chemicals into the wastewater or regular cleaning and maintenance of sewer structures. Treatment techniques include air filtering, air venting, and odor absorbers. Deodorant blocks also can mask odors.

4.4 Fisheries and Biological Resources

Fisheries and biological resources include resident and migrant species and the following aquatic and terrestrial habitats: nearshore, riparian corridors, freshwater wetlands, forest, natural areas, and landscaped areas. The study area includes portions

of the neighborhoods of Ballard, Fremont, Wallingford, and Queen Anne, and the Ship Canal east of the Hiram M. Chittenden Locks.

Federally listed threatened and endangered species that could potentially occur in the study area are Chinook salmon, steelhead, bull trout, marbled murrelet, and yellow-billed cuckoo. The yellow-billed cuckoo is unlikely to be found in the study area due to lack of available habitat (U.S. Fish and Wildlife Service, 2014). Critical habitat has been designated in the study area for Chinook salmon and bull trout; the final critical habitat designation for steelhead excludes the Lake Washington watershed. No populations of threatened or endangered plant species are documented in the study area (Washington Natural Heritage Program, 2015).

4.4.1 Ship Canal

Habitat and cover are limited in the Ship Canal, as its shoreline is almost completely armored and includes many bulkheads, docks, and piers (SPU and U.S. Army Corps of Engineers, 2008). Water quality is generally good due to the large inflow from Lake Washington, but seasonal temperature and dissolved oxygen problems occur, as well as occasional problems with fecal coliform bacteria levels and contaminants. There are also contaminated sediments in the project study area.

The project area provides poor salmon habitat. While salmonids migrate through the area, the Ship Canal is unlikely to be used extensively by salmonids for holding and foraging. In Salmon Bay near the West Portal site, the shoreline is lined with docks providing long-term and active boat moorage and there is very little riparian or upland vegetation. Adult salmonids migrate into the Ship Canal from Puget Sound through the Locks or the fish ladder at the Locks. Adult salmonids tend to migrate fairly quickly through the Ship Canal, with an average passage time of 1 to 4 days depending on species. Juvenile salmonids outmigrate through the Locks and fish ladder, but can also travel via culverts used to divert freshwater into the Locks, the smolt passage flumes, or the spillway gates (SPU and U.S. Army Corps of Engineers, 2008).

Chinook salmon smolts usually take 1 to 4 weeks to pass through the Ship Canal, whereas sockeye and Coho salmon take less than one week. Adult outmigrating salmon, in particular Chinook salmon, often hold just upstream from the Locks in a cool water refuge near the saltwater drain before going through the Locks (SPU and U.S. Army Corps of Engineers, 2008).

The project area is within the federally adjudicated usual and accustomed fishing areas of the Muckleshoot Indian Tribe and the Suquamish Tribe. Treaty Indian tribes have a right to harvest fish free of state interference, subject to conservation principles; to co-manage the fishery resource with the state; and to harvest up to 50 percent of the

harvestable fish. Tribal fishing occurs at various times of the year, depending on the timing of adult returns, the number of returning adults, and the associated harvest quotas.

4.4.2 Terrestrial Habitats and Wetlands

The proposed West Portal, East Portal, drop shafts, and conveyance areas are urbanized and consist primarily of paved areas. However, they do contain pockets of greenspace with lawn grass, shrubs, and some trees that could provide habitat for urban wildlife such as crows, gulls, raccoons, and rodents. The South 3rd Avenue Drop Shaft is proposed within a paved parking area of West Ewing Mini Park. Conveyance areas are primarily within city rights-of-way consisting mainly of paved streets or sidewalks but also some street trees. Street trees provide limited habitat for urban wildlife, particularly birds. There are no wetlands within the identified project area.

A great blue heron nesting colony is located in Commodore Park, on the south bank of the Ship Canal and adjacent to the Ballard Locks. Washington Department of Fish and Wildlife (WDFW) lists the great blue heron as a priority species and has established management recommendations for protecting the species and its habitat. The City of Seattle also protects great blue heron and their nesting colonies in its critical areas regulations (Seattle Municipal Code [SMC] 25.09.200.D) and Director's Rule 5-2007 (City of Seattle, 2007). The City of Seattle is currently updating the Director's Rule. Both WDFW and the City establish management buffers for heron colonies and restrict certain disturbances within those buffers during nesting season (February 1 through July 31).

4.5 Land and Shoreline Use and Visual Quality

The study area for land use, shoreline use, and visual quality consists of portions of the Ballard, Fremont, and Wallingford neighborhoods on the north side of the Ship Canal and a small area on the south side of the Ship Canal in the North Queen Anne neighborhood.

4.5.1 Land and Shoreline Use

4.5.1.1 Storage Tunnel

The 2.7-mile tunnel alignment will be located entirely underground and will have a depth of 50 to 100 feet for most of its alignment. The tunnel will be located primarily under street rights-of-way in areas zoned industrial and commercial (see Figure 4-1). These areas are developed with a variety of industrial, general commercial, warehouse, office, retail, and utility uses. There are two areas zoned residential (one-block and three-block areas). The tunnel alignment generally follows paved arterial or secondary streets and attempts to avoid residential street rights-of-way and private property whenever possible.

The City of Seattle Shoreline Management Plan (SMP) regulates development within 200 feet of the ordinary high water mark (OHWM) of the Ship Canal as well as overwater construction. Two separate areas of the tunnel alignment pass through Seattle's shoreline jurisdiction: (1) an area on Shilshole Avenue NW near the convergence of 20th Avenue NW and NW Dock Place that is developed with a private marina on the south side of Shilshole Avenue NW, and (2) an area on NW 45th Street immediately east of the Ballard Bridge at 15th Avenue NW that is the site of the Seattle Maritime Academy on the south side of NW 45th Street. Both of these areas are designated as Urban Industrial (UI) shoreline environments.

4.5.1.2 West Portal, East Portal, Drop Shafts

The West Portal site will be located on a 2.15-acre City-owned lot zoned Industrial General (IG) 1 and IG-2. The SMP designation of the upland portion of the site within 200 feet of the OHWM is UI. The East Portal will be located on a vacant 0.57-acre City-owned property zoned Commercial 2 – 30 (C-2). The 11th Avenue Drop Shaft will be located in the public right-of-way in an area zoned IG-2. The North 3rd Avenue/174 Drop Shaft will be located in the public right-of-way in an area zoned Industrial Buffer. The South 3rd Avenue Drop Shaft will be located in the parking lot of the City of Seattle's West Ewing Mini Park in an area zoned C-2. This area is within 200 feet of the OHWM and is designated Urban General (UG) shoreline environment.

4.5.1.3 Conveyance

Approximately 3,300 linear feet of conveyance pipelines will be constructed, primarily in public rights-of-way. Similar to the storage tunnel, the underground conveyance pipelines will cross many zones and in a few limited cases will be within SMP jurisdiction. The 3rd Avenue W microtunnel crossing under the bed of the Ship Canal is located in a Conservation Navigation (CN) shoreline environment. The shoreline environment abutting the CN district on the north side of the Ship Canal is designated UI. The shoreline environment abutting the CN district on the south side of the Ship Canal is designated UG.

4.5.2 Visual Quality

Most of the Ship Canal WQ Project's facilities will be constructed below ground and will have no long-term effects on visual quality along the 2.7-mile alignment. The proposed aboveground structures will be located mainly in developed commercial and industrial areas. As described in the 2014 EIS (SPU, 2014b), there are no protected views under the Seattle Municipal Code at any of the project locations.

At the West Portal, the general visual character of the upland area is dominated by commercial and industrial uses. In the immediate vicinity of the 24th Avenue NW pier,

the view is dominated by commercial/industrial and recreational maritime uses. Other piers provide commercial and private moorage for small, medium, and large vessels. There is a large commercial dry dock repair facility to the west of the 24th Avenue NW pier and a covered private marina to the east. The Ship Canal waterway in this part of Salmon Bay is heavily used by commercial and recreational boat traffic heading both westbound and eastbound.

The general visual character of the East Portal area is mixed-use commercial/residential. However, the bulk and scale of the adjacent SPU North Transfer Station, which occupies a one-block by three-block area, dominates the visual character of the immediate area near the East Portal site. The East Portal site itself is currently in use as leased parking.

The visual character of the intermediate drop shaft areas is dominated by commercial, industrial, and utility uses. The South 3rd Avenue Drop Shaft site is within the West Ewing Mini Park adjacent to the south side of the Ship Canal. Other than the paved parking lot, the West Ewing Mini Park is well vegetated with a mixture of trees, shrubs, and grasses.

4.6 Recreation

Within the study area, there are several City of Seattle parks (including West Ewing Mini Park and the Burke-Gilman Trail), several public access sites along the Ship Canal, recreation facilities associated with Seattle Pacific University, streets used for passive recreation such as bicycle riding, and in-water recreation in the Ship Canal. Amenities and uses of these recreational facilities are summarized below.

4.6.1 Ship Canal

The Ship Canal is used for in-water recreation by boaters, kayakers, paddle boarders, and others. Many marinas are located along the shores of the Ship Canal in the project vicinity.

4.6.2 Hiram M. Chittenden Locks

This site is a major tourist destination for the Ballard neighborhood. It is popular with recreational boaters and the grounds are operated as a park, with walking paths, lawn areas, a visitor's center, viewing windows to a fish ladder, and botanical gardens. Boat watching is a major visitor use of the Locks. Visitors can cross the Locks by foot, and bicyclists and pedestrians often cross the Locks to travel between Magnolia and Ballard as an alternative to the Ballard Bridge.

4.6.3 Ship Canal Trail

The Ship Canal Trail is a multiuse trail along the south shore of the Ship Canal from Lake Union to the Ballard Bridge. The trail, used by bicyclists and walkers, runs through West Ewing Mini Park adjacent to the project area.

4.6.4 Seattle Pacific University Athletic Fields and Facilities

Seattle Pacific University's athletic facilities are located directly adjacent to the Ship Canal Trail. The facilities include Wallace Athletic Field, Royal Brougham Pavilion, and the Crew Dock and are used for school and sporting events. The field is open to the public.

4.6.5 West Ewing Mini Park

West Ewing Mini Park is a small waterfront park on the south side of the Ship Canal. The park features lawn/open space, an overlook with benches, picnic tables, and the Ship Canal Trail.

4.6.6 Shilshole Avenue NW and Other Streets in the Project Area

Shilshole Avenue NW is commonly used by bicyclists and other recreational users despite the lack of a dedicated bicycle lane or sidewalks along the southwest side of the road. Shilshole Avenue NW is one of three potential routes for the proposed Burke-Gilman Trail Extension Project (also known as the "Missing Link" project). Similar to Shilshole Avenue NW, all other streets in the project area are used for informal recreation such as bicycling and walking.

4.6.7 Burke-Gilman Trail

The Burke-Gilman Trail is a 19.8-mile-long multiuse trail used by walkers, runners, cyclists, and skaters. Within the project area, the trail runs from Golden Gardens Park to the Locks. The trail resumes at NW 45th Street and 11th Avenue NW and runs along the Ship Canal to the University of Washington campus, where it turns north and continues to Bothell. The Burke-Gilman Trail is adjacent to the proposed 11th Avenue Drop Shaft and North 3rd Avenue/174 Drop Shaft sites and Wallingford conveyance (connection) area. Burke-Gilman Trail users often ride along Shilshole Avenue NW between the 11th Avenue NW and 30th Avenue NW segments of the trail.

4.6.8 Fremont Canal Park

The Fremont Canal Park, operated by Seattle Department of Parks and Recreation, is a small linear park adjacent to the Ship Canal in Fremont. The park features a lawn area/open space, a pedestrian trail, benches, and a viewing platform.

4.6.9 Ship Canal Access at Street Ends

Street ends throughout the Ballard neighborhood are designated shoreline street ends, which provide public shoreline access and views. Some street ends feature piers or boat ramps, while others simply feature a public space adjacent to the Ship Canal providing views of the water. Public amenities in the project area include:

- **11th Avenue NW Street End.** Native plantings, a shoreline viewing platform, a bench swing, and birdhouses.
- **Public Access Ramp at 14th Avenue NW.** Free public boat ramp providing access to the Ship Canal.
- **20th Avenue NW/Dock Place NW Street End.** Shoreline access.
- **Pier at 24th Avenue NW Street End.** Seattle Department of Transportation (SDOT) owns the existing pier at the 24th Avenue NW street end, and it is maintained by Seattle Parks and Recreation. This pier is used by recreationists for water access, shoreline viewing, and limited public vessel moorage. A potential future park at this site, called Threading the Needle Park, would include a pedestrian greenway, restored waterfront beach, upgraded dock, and stormwater gardens. The future park project is not currently scheduled or funded.
- **28th Avenue NW Street End.** Native plantings, water access, a kayak launch, and a basketball hoop.

4.7 Transportation

The study area for this transportation analysis includes all roadways, nonmotorized facilities, and transit and marine facilities that could be potentially disturbed by construction or operation of the project elements. Surface transportation facilities and services include streets and intersections, alleys, driveways, parking lots and spaces, sidewalks and other pedestrian facilities such as crosswalks, bus routes and stops, and railroad facilities. Marine facilities needed to accommodate potential construction-generated barges are also considered.

4.7.1 Roadway System

Roadways in the transportation study area have been classified as principal arterials, minor arterials, collector arterials, local street access, and alleys. The study area

roadways provide varying levels of access to adjacent properties and include numerous intersections with alleys and driveways. Some industrial and commercial properties have access along large portions of their frontages without delineated driveways.

Public parking is typically provided on the street. Metered parking present in the transportation study area typically has time limits of 2 to 4 hours. On-street parking is prohibited on some arterials during peak periods so that the lanes can be used to accommodate additional vehicle traffic. Private parking for residential, commercial, industrial, and institutional development is typically provided in off-street surface lots or garages.

4.7.2 Transit

Bus transit service in the transportation study area is provided by King County Metro Transit.

4.7.3 Nonmotorized Facilities

Streets in the Ballard, Fremont, Wallingford, and North Queen Anne neighborhoods generally have completed sidewalk networks. Signalized intersections typically include marked crosswalks with pedestrian signals.

In addition to sidewalks, non-motorized facilities include painted on-street bicycle lanes and marked roadway lanes. Some roadways without bicycle pavement markings are still identified by the City as bicycle routes that may be either signed or unsigned (City of Seattle, 2015a).

Two major multiuse trails traverse the study area:

- The **South Ship Canal Trail** is a 1.5-mile trail located adjacent to the south side of the Ship Canal between the Ballard (15th Avenue NW) Bridge and the Fremont Bridge.
- The **Burke-Gilman Trail** is a 19.8-mile trail with a west section located adjacent to Elliott Bay between Golden Gardens Park and the Hiram M. Chittenden Locks, and an east section that connects Ballard, Fremont, and the University of Washington, and then continues adjacent to Lake Washington from Seattle's Ravenna neighborhood through north Seattle, Lake Forest Park, and Bothell.

The Burke-Gilman Trail Extension (Missing Link) Project, currently in the planning process, would connect the existing east and west portions of the Burke-Gilman Trail through the Ballard neighborhood to complete the regional trail. Three alternatives have been defined, located primarily along NW Leary Way, NW Ballard Way, and Shilshole Avenue NW, respectively. Portions of all three alternatives are located in the transportation study area (City of Seattle, 2015b).

4.7.4 Freight Movement

Freight movement in the project study area occurs by truck, rail, or barge. Roadway characteristics and potential issues for major truck streets are similar to those of any other arterial roadway, but the streets are likely to carry a higher proportion of truck traffic.

The Ballard Terminal Railroad Company rail line operates a Class III (short-line terminal) rail line that is about 3 miles long between the Shilshole area (east of Seaview Avenue NW at about Ray's Boathouse restaurant) and NW 40th Street, west of Leary Way. The line is just south of and adjacent to Shilshole Avenue NW, between the roadway and the project site. BNSF Railway services Ballard Terminal Railroad out of the Interbay yard. The interchange of rail cars between Ballard Terminal Railroad Company and BNSF Railway (called Ballard Junction) is located to the north of NW 68th Street.

Although no marine freight traffic is currently generated in the project study area, barges could directly access a portion of the project site via a pier in Salmon Bay, located at the 24th Avenue NW street end. Barges are required to adhere to the rules of marine navigation established by the U.S. Coast Guard and the U.S. Army Corps of Engineers.

4.7.5 Marine Traffic

Salmon Bay is located on the south side of the transportation study area, connecting Shilshole Bay to the west to the Ship Canal to the east. Marine traffic through Salmon Bay includes a mix of commercial, recreational, and tribal fishing vessels that travel between Lake Washington/Lake Union and Puget Sound (via Shilshole Bay). The Ballard Locks accommodate vessel traffic 24 hours per day, 7 days per week.

4.8 Noise and Vibration

The Ship Canal WQ Project is located in a primarily commercial and industrial setting. The predominant noise sources include traffic, aircraft, pedestrians, and construction noise from nearby projects. The existing sound and vibration levels reflect the urban roadway traffic in the area, pedestrian traffic, aircraft noise, and nature sounds typically found in the area.

4.9 Energy and Climate Change

4.9.1 Energy

Federal, state, and local regulations apply to energy consumption by buildings and infrastructure. Most of these regulations apply to occupied buildings and are not applicable to CSO control or stormwater facilities.

Energy that powers the project area is supplied by Seattle City Light (electricity) and Puget Sound Energy (natural gas).

4.9.2 Climate Change

Seattle's greenhouse gas emissions originate from three main sources: transportation, buildings, and industry. Transportation accounts for 62 percent of emissions, with two-thirds of transportation emissions coming from cars and trucks. Energy use in buildings accounts for 21 percent, and industrial operations and processes make up the remaining 17 percent of emissions (City of Seattle, 2008).

Risks to utilities associated with climate change include changes in precipitation levels, intensity, or duration; timing of wet and dry seasons and flooding; soil moisture and infiltration rates; stormwater runoff; reduced winter snowpack and earlier snowmelt; and sea level rise.

4.10 Historic, Cultural, and Archaeological Resources

The study area for aboveground cultural resources includes the location of the TEPS at the West Portal site, the generator building at the East Portal site, and associated open cut excavations at each end of the storage tunnel. The study area for archaeological cultural resources is the footprint of the tunnel portals, conveyance facilities, drop shafts, and other near-surface impacts, plus each adjacent parcel. The storage tunnel alignment is not included in the study area because the proposed depth of the tunnel is within Pleistocene soils and therefore predates human occupation of the Puget Sound region.

Because construction of the proposed Ship Canal WQ Project is expected to be underway in 2017 and continue to 2024, SPU has chosen to evaluate existing buildings in the cultural resources study area based on what their age will be in 2024.

4.10.1 Historic

The analysis of historic aboveground resources focused on two datasets: (1) buildings currently listed on a historic register, and (2) buildings that meet minimum age thresholds to be considered for listing but have not yet been documented and/or evaluated for inclusion in a historic register.

Data sources included the Washington Information System for Architectural and Archaeological Records Data (WISAARD), the City of Seattle Landmarks Registry, and the King County Department of Assessment. Many historic-age properties have been identified near the study area, but few of the properties have been evaluated for their eligibility to be included in a historic register. Tax parcel records were used to identify gaps in previous cultural resources surveys. Potential impacts to previously recorded

historic properties were determined through a review of project plans in relation to the location of historic-age properties. Potential impacts were also assessed using information provided in the noise and vibration analysis.

4.10.2 Archaeological

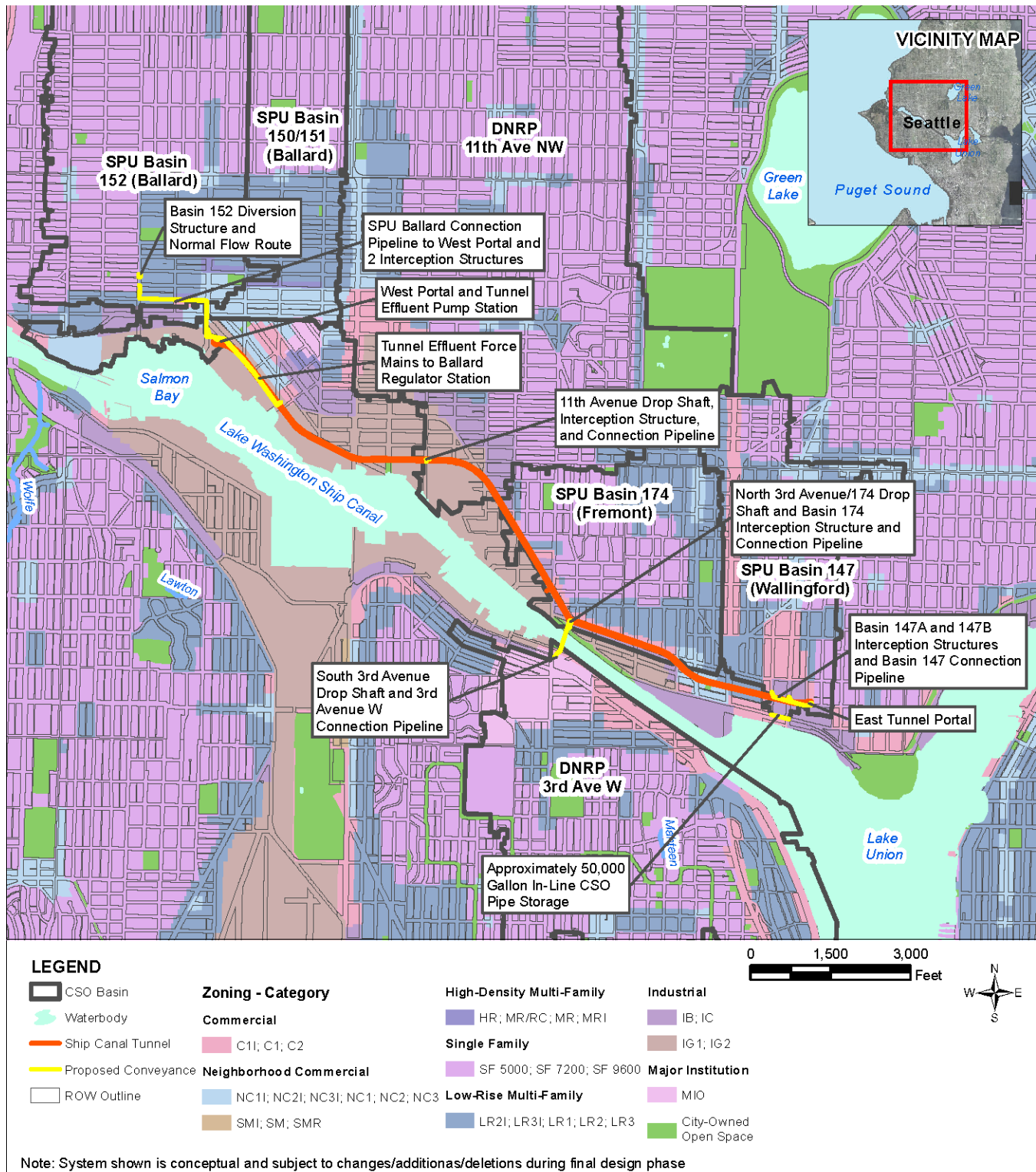
The analysis of archaeological resources focused on two datasets: (1) WISAARD, and (2) previous local geotechnical analyses. Analysts reviewed data produced in the 2014 geotechnical investigation for this project (Shannon & Wilson, 2014), as well as other geotechnical analyses conducted in the project vicinity. Buried cultural resources are not usually expected to be present more than 25 feet below the ground surface. Unless these properties were considered eligible to be included on a historic register, they would not require any specific consideration or mitigation.

4.10.3 Historic Properties in the Project Area

Three previously documented historic register properties are located in the project study area. The Seattle Lake Shore and Eastern Railroad Grade (now known as the Ballard Terminal Railroad alignment) and the Stimson Lumber Company Office are both located adjacent to the West Portal site. The Seattle Boiler Works is adjacent to the tunnel alignment. These were each determined eligible for listing on the National Register of Historic Places (NRHP) by the Washington State Department of Archaeology and Historic Preservation (DAHP). Additionally, three historic districts are adjacent to or overlapping portions of the study area.

Dozens of other properties in the study area meet the minimum age threshold for inclusion on a historic register but have not been evaluated; many of these are assumed to not meet historic register significance criteria. Historic-age properties adjacent to the West and East Portals have been recommended not eligible for inclusion on a historic register, but no formal determination of eligibility has been made by DAHP. To comply with City of Seattle Code (SMC 25.05.675.H), the City-owned public 24th Avenue NW pier, which was built in 1935 and would be directly impacted by the project, was evaluated and recommended not eligible for listing as a Seattle City Landmark.

No archaeological sites have been recorded within the study area; however no surveys have been conducted. Archaeological monitoring is recommended for excavation in intact Holocene strata.



5 Existing Conditions

This chapter describes the existing combined sewer systems served by the Ship Canal WQ Project.

5.1 Infrastructure Overview

The Ship Canal WQ Project controls six combined sewer basins and their seven respective outfalls:

- SPU Basin 152 (Ballard)
 - Outfall 152
- SPU Basin 150/151 (Ballard)
 - Outfall 150
 - Outfall 151
- DNRP 11th Avenue NW
 - Outfall 11th Avenue NW (DSN004)
- SPU Basin 174 (Fremont)
 - Outfall 174
- SPU Basin 147 (Wallingford)
 - Outfall 147

In addition, one basin and one outfall are on the south side of the Ship Canal:

- DNRP 3rd Avenue W
 - Outfall 3rd Avenue W (DSN008)

Figure 5-1 shows the locations of the outfalls addressed by the Ship Canal WQ Project. Outfalls 152, 150, 151, 174, and 147 are under the jurisdiction of SPU; 11th Avenue NW and 3rd Avenue W are under the jurisdiction of DNRP.

Infrastructure serving the project basins includes the components listed below, which are described in the following sections:

- SPU Ballard area (Basins 152 and 150/151)
 - More than 186,000 linear feet of sewer mainlines ranging between 6 and 48 inches in diameter
 - More than 750 connecting structures, most of which are maintenance holes

- Basin 152
 - Approximately two-thirds of the combined sewer area's pipes and connecting structures
 - Pump Station 84
 - Overflow Structures 152A and 152B
 - Outfall 152 at southernmost end of 28th Avenue NW
- Basin 150/151
 - Approximately one-third of the combined sewer area's pipe and connecting structures
 - Overflow Structure 150/151
 - Outfalls 150 and 151 south of 24th Avenue NW and NW 54th Street
- DNRP 11th Avenue NW combined sewer area
 - More than 12,500 linear feet of DNRP sewer mainlines ranging from 24 inches in diameter to a box conduit 116 inches in width
 - More than 350,000 linear feet of SPU combined sewer and sewer mainlines ranging between 6 and 64 inches in diameter
 - 39 DNRP maintenance holes
 - More than 1,000 SPU connecting structures, most of which are maintenance holes
 - 11th Avenue NW Overflow Structure
 - 11th Avenue NW Outfall (DSN004) at southernmost end of 11th Avenue NW
- SPU Fremont and Wallingford areas (Basins 174 and 147)
 - More than 125,000 linear feet of sewer mainlines ranging between 8 and 54 inches in diameter
 - More than 640 connecting structures, most of which are maintenance holes
 - Basin 174
 - Slightly more than half of the combined sewer area's pipe and connecting structures
 - Overflow Structure 174
 - Outfall 174 south of 2nd Avenue NW and NW Canal Street
 - Basin 147
 - Slightly less than half of the combined sewer area's pipe and connecting structures
 - Overflow Structures 147A and 147B

- Outfall 147 at southernmost end of Stone Way N
- DNRP 3rd Avenue W combined sewer area
 - Approximately 10,700 linear feet of DNRP sewer mainlines ranging between 42 and 108 inches in diameter
 - Approximately 148,000 linear feet of SPU combined sewer and sewer mainlines ranging between 6 and 108 inches in diameter
 - 21 DNRP maintenance holes
 - More than 540 SPU connecting structures, most of which are maintenance holes
 - 3rd Avenue W Overflow Structure
 - 3rd Avenue W Outfall (DSN008) northeast of W Ewing Street and 3rd Avenue W

5.2 Basins and Flow Routes

Characteristics of the six CSO basins (152, 150/151, 11th Avenue NW, 174, 147, and 3rd Avenue W) in the project area are described in the following subsections, grouped by area.

5.2.1 Seattle Public Utilities Ballard Combined Sewer Area (152 and 150/151)

The SPU Ballard area consists of two basins:

- Basin 152 – approximately 769 acres
- Basin 150/151 – approximately 401 acres

Figures 5-2 and 5-3 show the combined sewer, sanitary sewer, and drainage systems for the basins in the Ballard area.

The Ballard area comprises Basins 152 and 150/151, which drain from north to south toward the Ship Canal and Salmon Bay. The wastewater generated in these basins flows by gravity in the SPU combined sewer system to DNRP's Ballard Regulator Station and into the Ballard Siphon for conveyance to the West Point Treatment Plant. Basins 152 and 150/151 contain permitted CSO outfalls that discharge overflows to Salmon Bay during large precipitation events when the capacity of the combined sewer system is exceeded. Salmon Bay is located on the freshwater (east) side of the Hiram M. Chittenden Locks.

Outfall 152 is located at 28th Avenue NW and NW Market Street. This pipe is a wood-stave pipe and is in good condition. There are currently no plans to replace or repair this outfall.

Flows from Basin 150/151 combine upstream of the outfalls at Overflow Structure 150/151, then continue through a shared pipe to a splitter structure before flowing to

Outfalls 150 and 151. Outfall 151 is a wood-stave pipe that is in poor condition, and rehabilitating it during Ship Canal Project construction will be less disruptive to the community than rehabilitating it in a separate construction project. SPU plans to replace both the existing 18-inch-diameter Outfall 151 and the existing 30-inch-diameter high-density polyethylene (HDPE) Outfall 150 with a single HDPE 48-inch-diameter outfall that meets current and future needs. This replacement Outfall 151 will be installed under the reconstructed 24th Avenue NW Pedestrian Pier.

5.2.2 King County Department of Natural Resources and Parks 11th Avenue NW Combined Sewer Area

The DNRP 11th Avenue NW Basin contains approximately 1,352 acres and is located in the Greenwood and Ballard neighborhoods. The sewer flows north to south in this basin. At the northern part of the basin, DNRP's system receives flows from the Carkeek Pump Station (which receives flows from the North Beach Pump Station, Broadview, and Greenwood areas), which are then conveyed south in the 8th Avenue NW Interceptor to the Ballard Trunk. The Ballard Trunk passes through the 11th Avenue NW Overflow Structure. Dry-weather flows are directed west and out of the 11th Avenue NW Basin in the Ballard Trunk to the Ballard Regulator Station. From this location, flows pass through the Ballard Siphon to join the North Interceptor on the south side of Salmon Bay. The North Interceptor continues westward to the West Point Treatment Plant.

Overflow from the 11th Avenue NW Overflow Structure continues south to Salmon Bay in a 60- to 72-inch-diameter outfall. Figure 5-4 shows the combined sewer, sanitary sewer, and drainage systems for the 11th Avenue NW basin.

5.2.3 Seattle Public Utilities Fremont and Wallingford Combined Sewer Areas (174 and 147)

The SPU Fremont and Wallingford areas are comprised of Basins 148, 174, and 147, which drain from north to south toward Lake Union and the Ship Canal. The following two basins are uncontrolled:

- Basin 174 – approximately 349 acres
- Basin 147 – approximately 295 acres

Figures 5-5 and 5-6 show the combined sewer, sanitary sewer, and drainage systems for the basins in the Fremont and Wallingford areas.

Basins 148 and 174 each have a single overflow structure and outfall. Basin 148, which is controlled and is not part of the Ship Canal WQ Project, flows by gravity to Pump Station 54, which transfers flow to Basin 174. The sewage from these basins flows by gravity to DNRP's North Interceptor for conveyance to the West Point Treatment Plant.

Basins 174 and 147 contain permitted CSO structures that discharge overflows to Lake Union and the Ship Canal during large precipitation events when the capacity of the combined sewer system is exceeded or when the DNRP North Interceptor levels are high. Basin 174 overflows during storm events at Outfall 174. Basin 147 has two overflow structures (147A and 147B), which discharge to a single outfall.

5.2.4 King County Department of Natural Resources and Parks 3rd Avenue W Combined Sewer Area

The DNRP 3rd Avenue W Basin contains approximately 694 acres and is located in the north Queen Anne neighborhood. Dry-weather flows from the Dexter Regulator Station and Galer Street Overflow Chamber enter the 3rd Avenue W basin and continue to flow northerly in the Central Trunk along the west side of Lake Union. The Central Trunk alignment turns to the northwesterly along the southerly side of the Ship Canal and turns north and enters the 3rd Avenue W Overflow Structure. This overflow structure contains a weir and is the downstream end of the 3rd Avenue W Basin. Overflow from the 3rd Avenue W Overflow Structure continues northerly through a 39-inch-high by 60-inch-wide box conduit to discharge in the Ship Canal. Dry-weather flows from the 3rd Avenue W Overflow Structure continue north in the Central Trunk through a sand catcher and then join the North Interceptor. The North Interceptor conveys this flow to West Point Treatment Plant. Figure 5-7 provides a simplified flow schematic for the 3rd Avenue W Basin.

5.2.5 DNRP Conveyance and Structures

The basins addressed by the Ship Canal WQ Project ultimately flow to the DNRP conveyance system for treatment at the West Point Treatment Plant. The Ballard Trunk and Central Trunk (described above), North Interceptor, and Ballard and Fremont Siphons are the primary DNRP conveyance pipelines associated with the Ship Canal WQ Project. The order of farthest upstream to farthest downstream basins along the DNRP combined sewer system mainlines is Basin 147, 3rd Avenue W Basin, Basin 174, 11th Avenue NW Basin, Basin 150/151, and Basin 152.

Combined sewage from Basins 174 and 147 flows into the North Interceptor at locations in the Fremont and Wallingford neighborhoods, respectively, on the north side of the Ship Canal. The North Interceptor then conveys flows across the Ship Canal in the Fremont Siphon. On the south side of the Ship Canal and east of the Fremont Siphon, the 3rd Avenue W Basin flows into the Central Trunk. At the south side (outlet) of the Fremont Siphon, the Central Trunk merges with the North Interceptor and continues westward towards West Point Treatment Plant. The Fremont Siphon currently consists of approximately 500 feet of parallel 48-inch and 60-inch-diameter pipes underneath the

Ship Canal. DNRP is currently constructing a project to replace the Fremont Siphon with dual 60-inch-diameter pipes. This project is scheduled for completion in 2017.

Flows from the Ballard Trunk are connected to the North Interceptor via the Ballard Siphon. The siphon is comprised of three barrels: the wet-weather barrel is approximately 1,980 linear feet and 85.5 inches in diameter, and the twin dry-weather barrels are approximately 580 feet and 30 inches in diameter.

The North Interceptor from Basin 147, through the Fremont Siphon, and westward to the West Point Treatment Plant is approximately 33,000 linear feet of 108- inch to 144-inch-diameter pipe (including both the old and new Ft. Lawton tunnels).

5.3 Combined Sewer System Special Facilities

The combined sewer areas in the Ship Canal WQ Project contain special facilities (including structures and pump stations) to help manage combined sewer flow. Details for these structures are in Table 5-1.

Basins 152 and 150/151 in the SPU Ballard combined sewer area contain an existing pump station (Pump Station 84) and two CSO overflow structures containing weirs. Pump Station 84 is located in Basin 152 at the intersection of 28th Avenue NW and NW 54th Street and is a duplex pump station with constant-speed pumps and a maximum total capacity of 1.25 MGD. It collects wastewater from a 38-acre area and lifts flow from the lower portion of Basin 152 towards the SPU combined sewer system along NW Market Street. The pump station is configured to overflow during extreme wet-weather events via Overflow Structure 152A and has not overflowed in recent years (SPU, 2012c).

Basins 174 and 147 in the SPU Fremont and Wallingford areas contain three flap gates at connections with the DNRP North Interceptor and three CSO overflow structures containing weirs. The 11th Avenue NW Basin contains the 11th Avenue NW Overflow Structure. The 3rd Avenue W Basin contains the 3rd Avenue W Overflow Structure.

No pump stations are located in the 11th Avenue NW Basin, Basins 174 and 147 in the Fremont and Wallingford areas, nor in the 3rd Avenue W Basin.

Table 5-1. CSO Special Structures in Ship Canal Basins

Structure	Basin	Location
Pump Station 84	152	MH 011-219 in 28th Avenue NW south of NW 54th Street
Overflow Structure 152B	152	MH 011-189 in 28th Avenue NW north of NW Market Street
Overflow Structure 150/151	150/151	MH 011-184 in NW Market Street and Shilshole Avenue NW
Overflow Structure 174	174	MH 021-052 in 2nd Avenue NW between NW 36th Street and NW Canal Street
Flap Gate 174	174	MH 021-056 at 2nd Avenue NW and NW Canal Street
Overflow Structure 147B	147	MH 022-160 in Woodland Park Avenue N and N 34th Street
Flap Gate 147B	147	MH 022-177, upstream from DNRP interceptor connection at Phinney Avenue N and N Canal Street
Overflow Structure 147A	147	MH 022-187 in Stone Way N north of N 34th Street
Flap Gate 147A	147	MH 022-188, upstream from DNRP interceptor connection in Stone Way N and N 34th Street
11th Avenue NW Overflow Structure	11th Avenue NW	MH 012-165 in 11th Avenue NW between NW 45th Street and NW 46th Street
3rd Avenue W Overflow Structure	3rd Avenue W	MH 021-244 in 3rd Avenue W between W Ewing Street and W Nickerson Street

MH maintenance hole

5.4 Combined Sewer Outfall Outfalls

The Ship Canal WQ Project basins contain seven permitted outfalls. Outfalls 152, 150, and 151 discharge into Salmon Bay. Overflows from the 11th Avenue NW Overflow Structure (DSN004), Outfall 174, and 3rd Avenue W Overflow Structure (DSN008) discharge into the Ship Canal. Outfall 147 discharges into Lake Union. Table 5-2 provides details for each outfall.

Table 5-2. General Characteristics of Ship Canal WQ Project Outfalls

Outfall	Outfall Size, Material, and Description	Approximate Distance Outfall Extends from Shore (feet)	Approximate Depth of Outfall Discharge from Average Water Surface (feet, to invert)
152	48-inch-diameter wood-stave pipe	60	10
150 ^a	30-inch-diameter HDPE pipe, pile-supported mounting system	55	5.8
151 ^a	18-inch-diameter wood-stave pipe	175	12
11th Avenue NW (DSN004)	72-inch diameter concrete pipe connecting to overflow structure, then transitions to 60-inch-diameter wood-stave pipe	40	15
174 ^b	12-inch-diameter steel pipe	0; at headwall	0.5
3rd Avenue W (DSN008)	36-inch by 60-inch concrete box	20	3
147	30-inch-diameter concrete pipe	10	5

^a Existing Outfalls 150 and 151 will be replaced as part of this project with a single 48-inch-diameter HDPE pipe located under the reconstructed 24th Avenue NW Pedestrian Pier.

^b The land portion of Outfall 174 has been replaced and realigned as part of the DNRP Fremont Siphon Replacement Project

5.5 Sewer Classification and Pipeline Information

The project area includes partially separated sewers and combined sewers. Private owners are responsible for the sewer line from the home or business to the connection to the sewer main, while SPU or DNRP is responsible for the service connection at the sewer main.

The combined sewer system in the Ballard area conveys both sewage and stormwater flow. The area to the north of NW 65th Street (about two-thirds of the total area) is fully combined. The area south of NW 65th Street is partially separated. Storm drains collect and convey street runoff and a portion of private property runoff. Stormwater from partially separated areas of the Ballard area is discharged into the Ship Canal and Salmon Bay. Combined sewage is discharged into Salmon Bay during large precipitation events when the capacity of the combined sewer system is exceeded (SPU, 2012c).

Most of the 11th Avenue NW Basin (1,352 of the 1,418 acres) flows to the combined sewer system. Stormwater from the northern area of the 11th Avenue NW Basin flows to the combined sewer system, whereas stormwater from the southern area flows to the SPU separate storm drain system. Storm drains collect and convey a portion of street

runoff and a portion of private property runoff and discharge into the Ship Canal. Combined sewage is discharged into the Ship Canal during large precipitation events when the capacity of the combined sewer system is exceeded.

The combined sewer system in the Fremont and Wallingford areas conveys both sewage and stormwater flow. Most of the Fremont and Wallingford areas is partially separated. The area to the west of Stone Way N is partially separated. Storm drains collect and convey street runoff and a portion of private property runoff. Stormwater runoff from portions of Basin 148 and a few localized areas of Basin 174, drain to the combined sewer system. Stormwater from partially separated areas of the Fremont and Wallingford areas is discharged into the Ship Canal. Combined sewage is discharged into Lake Union (Basin 147) and the Ship Canal (Basin 174) during large precipitation events when the capacity of the combined sewer system is exceeded or when the DNRP North Interceptor levels are high (SPU, 2012c).

Most of the 3rd Avenue W Basin (694 of the 749 acres) flows to the combined sewer system. Storm drains collect and convey a portion of street runoff and a portion of private property runoff and discharge into Lake Union. Combined sewage is discharged into the Ship Canal during large precipitation events when the capacity of the combined sewer system is exceeded.

5.6 Wastewater Treatment

The SPU and DNRP combined sewer areas addressed by the Ship Canal WQ Project route wastewater flows to and through the DNRP regional system to the West Point Treatment Plant for secondary treatment.

The West Point Treatment Plant currently provides secondary treatment for flows up to 300 MGD and provides primary CSO treatment and disinfection for flows in excess of 300 MGD and up to 440 MGD. The West Point Treatment Plant is a Class IV treatment plant. The final effluent discharges through an outfall pipeline and diffuser into Puget Sound.

5.7 Drainage System

SPU also owns, operates, and maintains some storm drainage systems in the portions of the project area where stormwater and sewage flows have been partially separated. These storm drainage systems collect stormwater from the street rights-of-way and parking lots and convey the flow to stormwater outfalls that drain to the Ship Canal. Other stormwater (mainly from rooftops) enters the combined sewer system.

DNRP does not own any separate storm drainage systems in the project area.

Table 5-3 summarizes the main characteristics of the SPU drainage systems in the project area.

Table 5-3. SPU Separate Drainage System in the Project Area				
Basin	Storm Drain Mainline Length (feet)	Storm Drain Size (diameter in inches) ^a	Storm Drain Material	Dates Installed
152	15,700	8 to 12 (38%), 15 to 48 (59%), 72 (3%)	Reinforced concrete	1903 to 1974
150/151	11,300	12 (46%), 15 to 48 (54%)	Reinforced concrete	1972, 1974
11th Avenue NW	61,200	8 to 12 (42%) 15 to 48 (48%) 54 to 78 (10%)	Reinforced concrete	1943 to 2014
174	38,500	8 to 12 (61%), 15 to 18 (39%)	Reinforced concrete	1969 to 1974, 2007
3rd Avenue W	19,300	6 to 12 (72%) 14 to 48 (28%)	Reinforced concrete, ductile iron	1924, 1989 to 2012
147	30,400	8 to 12 (63%), 15 to 42 (37%)	Reinforced concrete	Majority 1968 to 1972, 2007 to 2013

^a Percentages noted describe that portion of the total length of pipe within the basin that is within the indicated range of pipe diameters.

5.8 Water and Sediment Quality of Combined Sewer Overflows

In 1988-1989 as part of the *1988-1997 Metro/King County CSO Discharge and Sediment Quality Characterization Study* (Metro and King County, 1998), overflow quality monitoring was performed in the Ship Canal at the 11th Avenue NW and 3rd Avenue W CSO outfalls, and one sediment sample proximal to each of the CSO outfalls was collected in May 1989.

Analysis of overflow samples from the DNRP outfalls showed that the variability between different samples at a single site was generally greater than the variability among sites. Sediment sampling confirmed that sediments had been significantly impacted by pollution and that the contamination resulted from many sources. A Sediment Management Plan (King County, 1999) was completed in 1999 to address historical contamination of sediments near CSO outfalls.

Since the 1988-1997 CSO characterization, pollutant concentrations have remained stable or have decreased. DNRP monitors West Point Treatment Plant influent and effluent, biosolids quality, and industrial sources (King County, 2009).

SPU submitted a Final PCMP (SPU, 2015b) to EPA and Ecology on May 29, 2015, for approval in accordance with the City's Consent Decree. The Final PCMP included an updated list of sampling locations and schedule. On August 26, 2015, the Final PCMP was approved subject to SPU submitting the following: (1) detailed Quality Assurance Project Plans (QAPPs) for review and approval, and (2) following approval of the QAPPs, sediment data reports for each surrogate outfall. Outfalls 152, 174, and 147 are among the 14 surrogate outfalls that will be analyzed as part of implementing the Final PCMP.

DNRP also has an approved PCMP that addresses monitoring of water and sediment quality.

5.9 Receiving Water Quality

Section 4.2 contains information on receiving water quality.

5.10 Infiltration and Inflow Studies

Flows in the combined and sanitary collection systems consist primarily of four components:

- **Sanitary sewage**—The mixture of domestic, commercial, and industrial wastewaters.
- **Inflow**—Stormwater introduced into a sanitary or combined sewer from roof drains, yard drains, basement drains, street catch basins, or other direct connections.
- **Infiltration**—Groundwater introduced into a sanitary or combined sewer through joints, the pipe material, cracks, and other defects below groundwater level; “base infiltration” denotes the rate of infiltration, which may fluctuate very slowly with the seasons.
- **Rain-induced infiltration**—Groundwater introduced into the sanitary or combined sewer as a direct result of a recent storm event. The points of entry into the sewer system may be the same as for infiltration, but rain-induced infiltration may include flow contributions from constructed improvements such as foundation drains that are not considered system defects. The points of entry of rain-induced infiltration may be located above the normal groundwater table and are activated by localized accumulations of rainwater at or near the ground surface during a storm event.

SPU's 2010 CSO Reduction Plan (SPU, 2010a) identified potential inflow and infiltration (I&I) control measures in several basins, including Basin 152. An analysis performed as

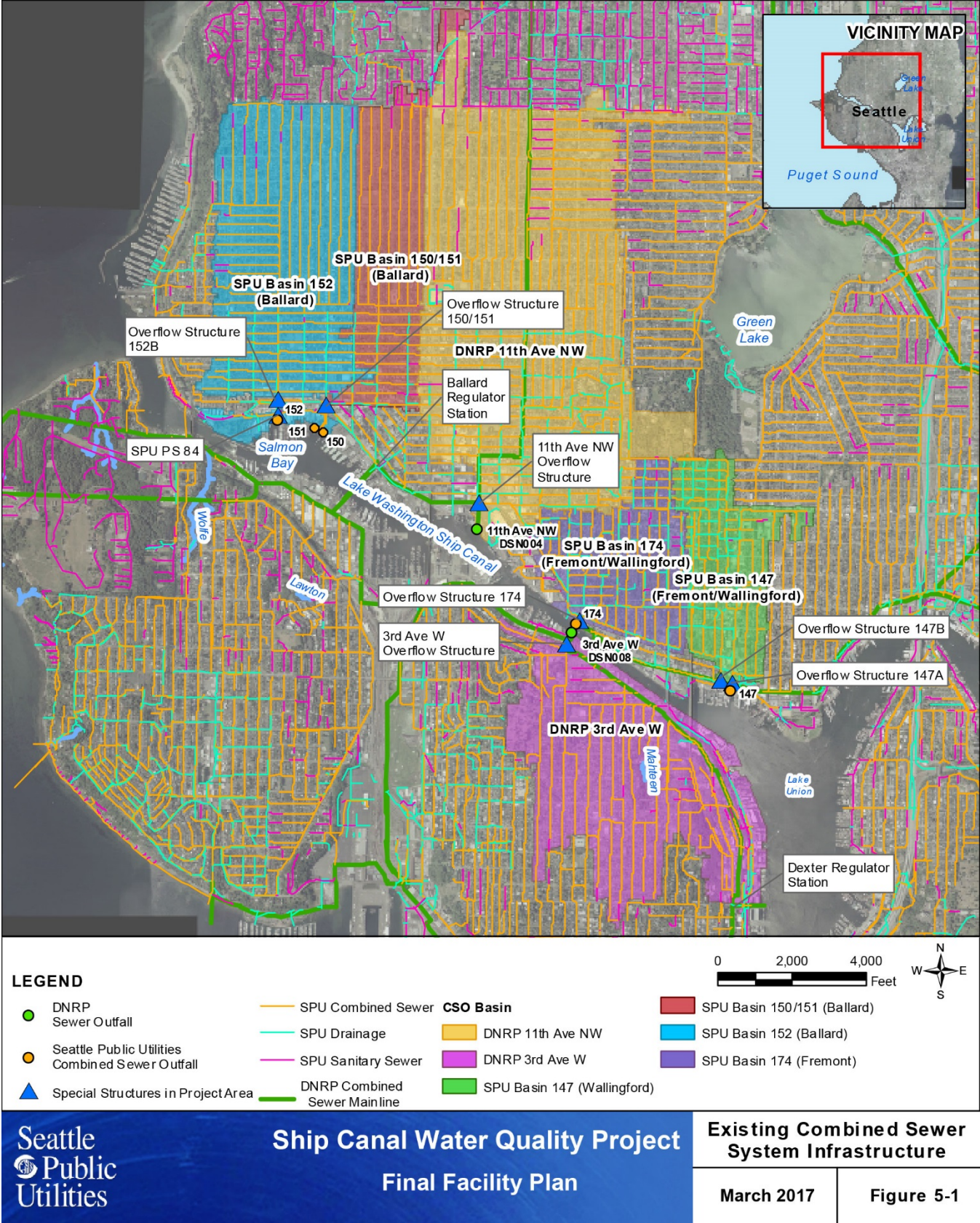
part of SPU's LTCP suggested that there is high potential for reducing control volume in Basin 152 (up to 99 percent) with I&I control measures (SPU, 2012d). From the I&I analysis, most flow in Basin 152 comes from private property at 23.46 MGD, with a much smaller portion from public rights-of-way at 4.14 MGD. However, I&I control measures were not recommended in the SPU LTCP because they were not cost-effective (SPU, 2015a).

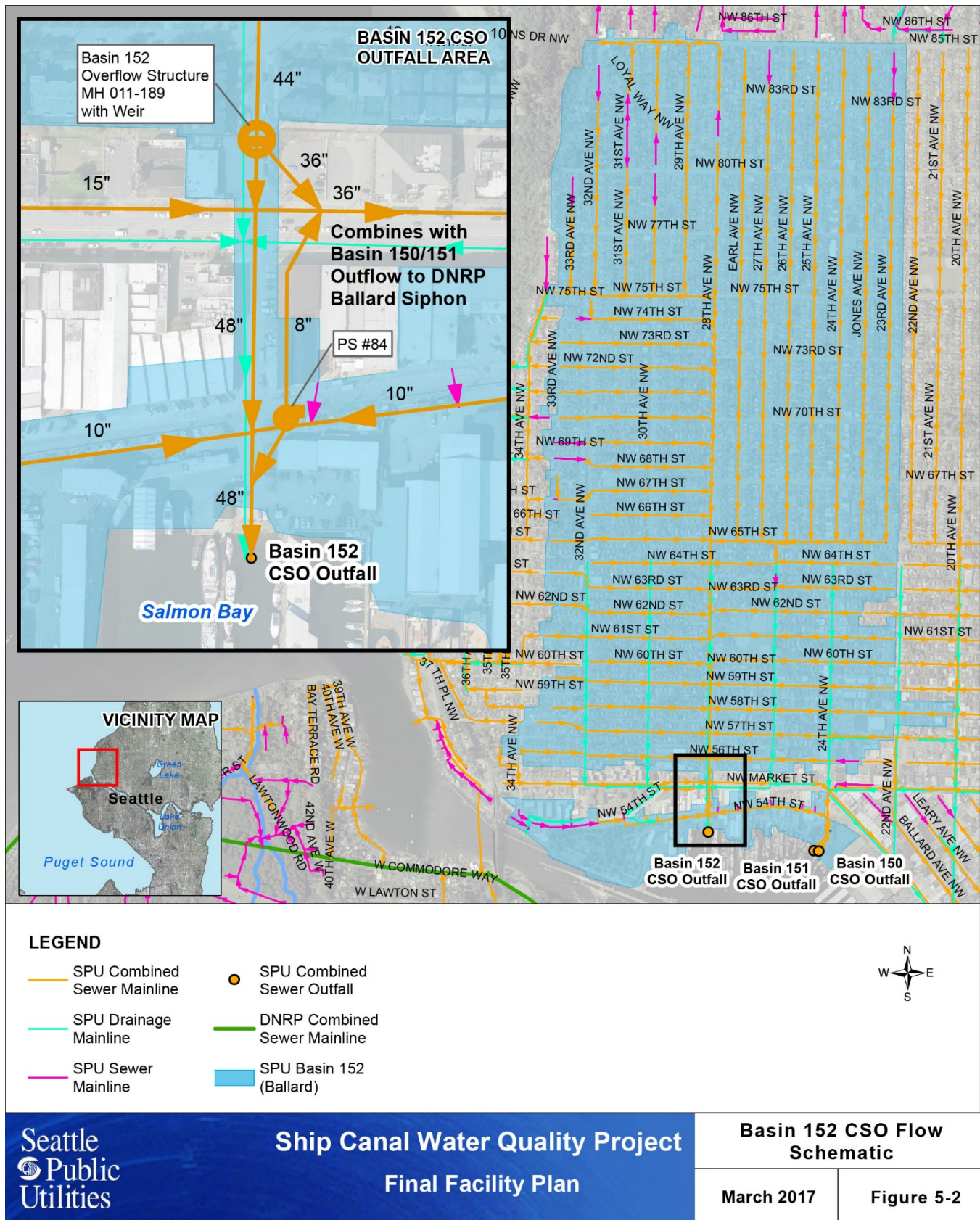
DNRP conducted a study during the infiltration and inflow rehabilitation pilot projects in 2003. The study found that most of the extraneous flow was from infiltration as opposed to inflow (King County, 2004). The study found very little inflow (for example, direct storm drainage connections). The study concluded that roughly 75 percent of infiltration originated on private property and 25 percent came from public rights-of-way.

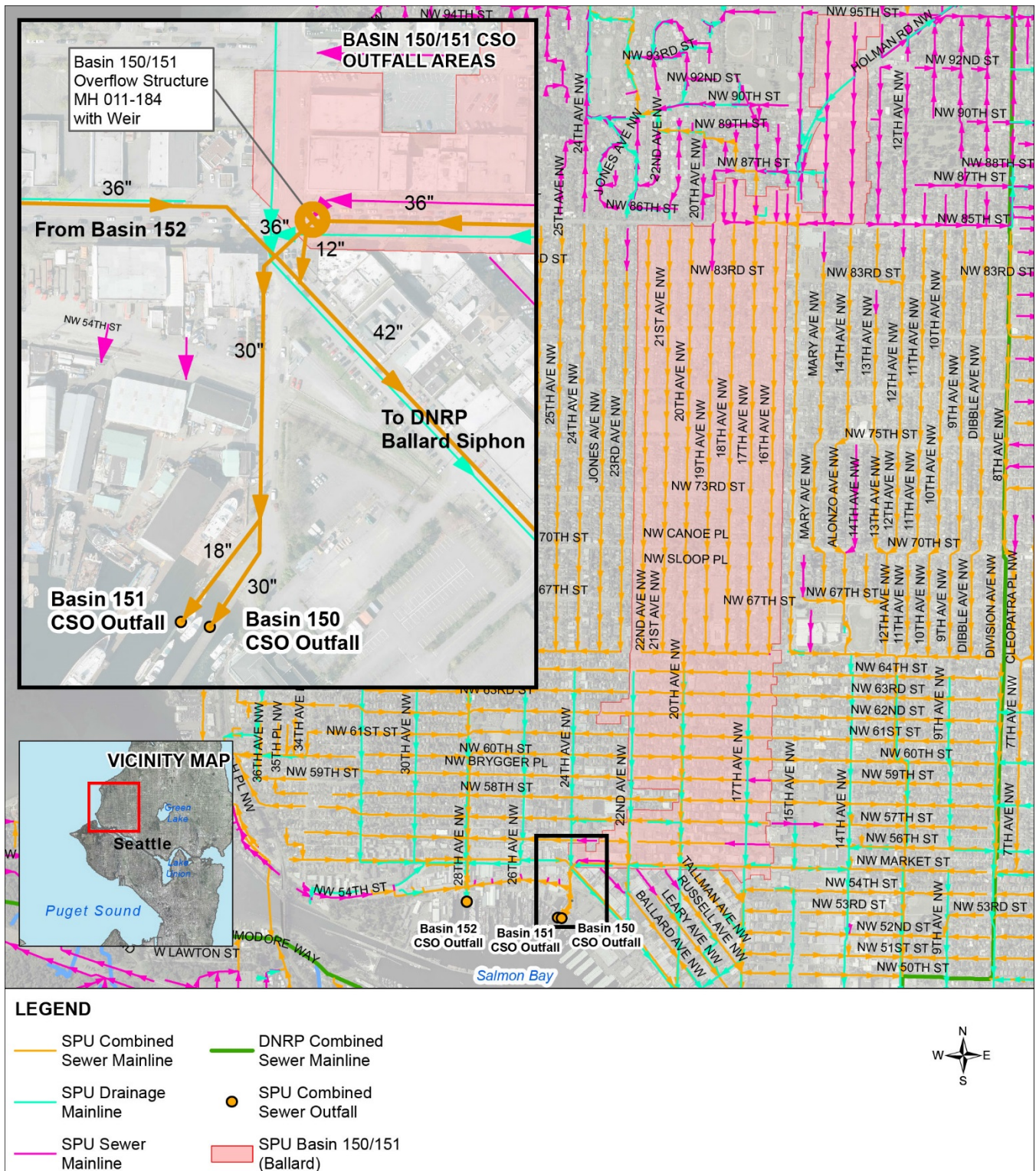
There are few data documenting how fast and how much degradation occurs in a collection system. For DNRP's planning purposes, the assumed rate of degradation of existing sewer infrastructure from 2000 conditions is 7 percent per decade, with a limit of 28 percent over a 40-year period applied to both average wet-weather and peak flows (King County, 2014a). For new sewer facilities, DNRP includes an allowance of 1,500 gallons per acre per day in the design flow for both the conveyance and treatment of wastewater in the regional system (King County, 2012a).

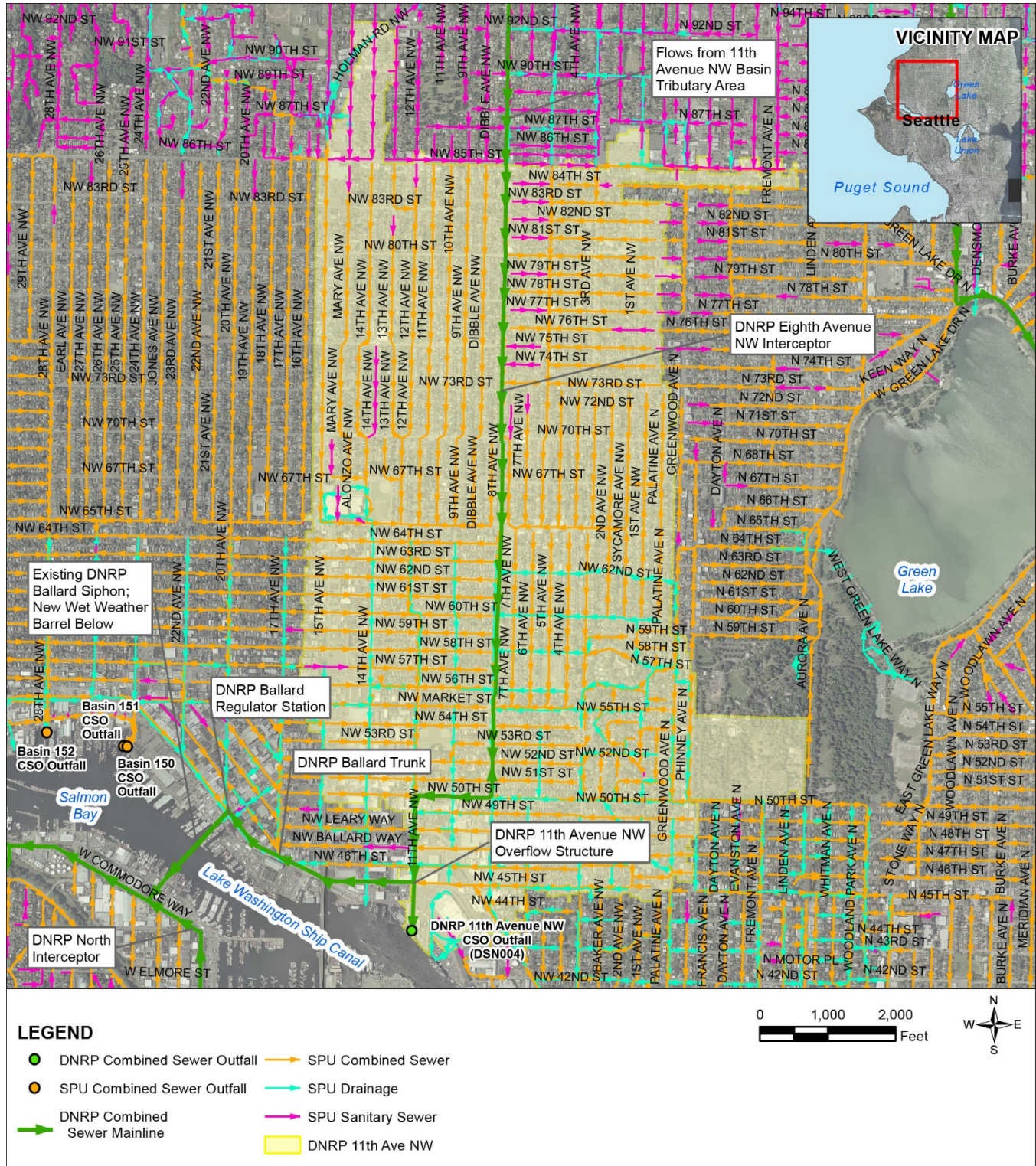
5.11 Sanitary Surveys for Unsewered Areas

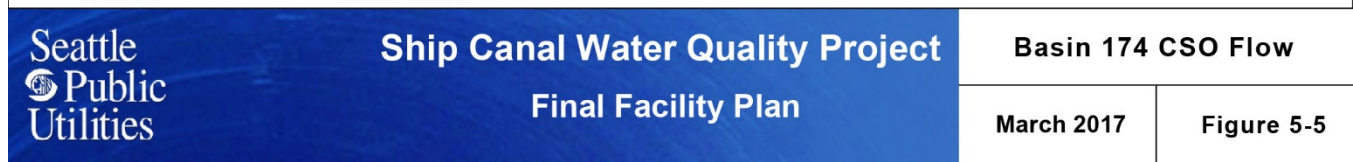
There are no unsewered areas in the Ship Canal WQ Project area.

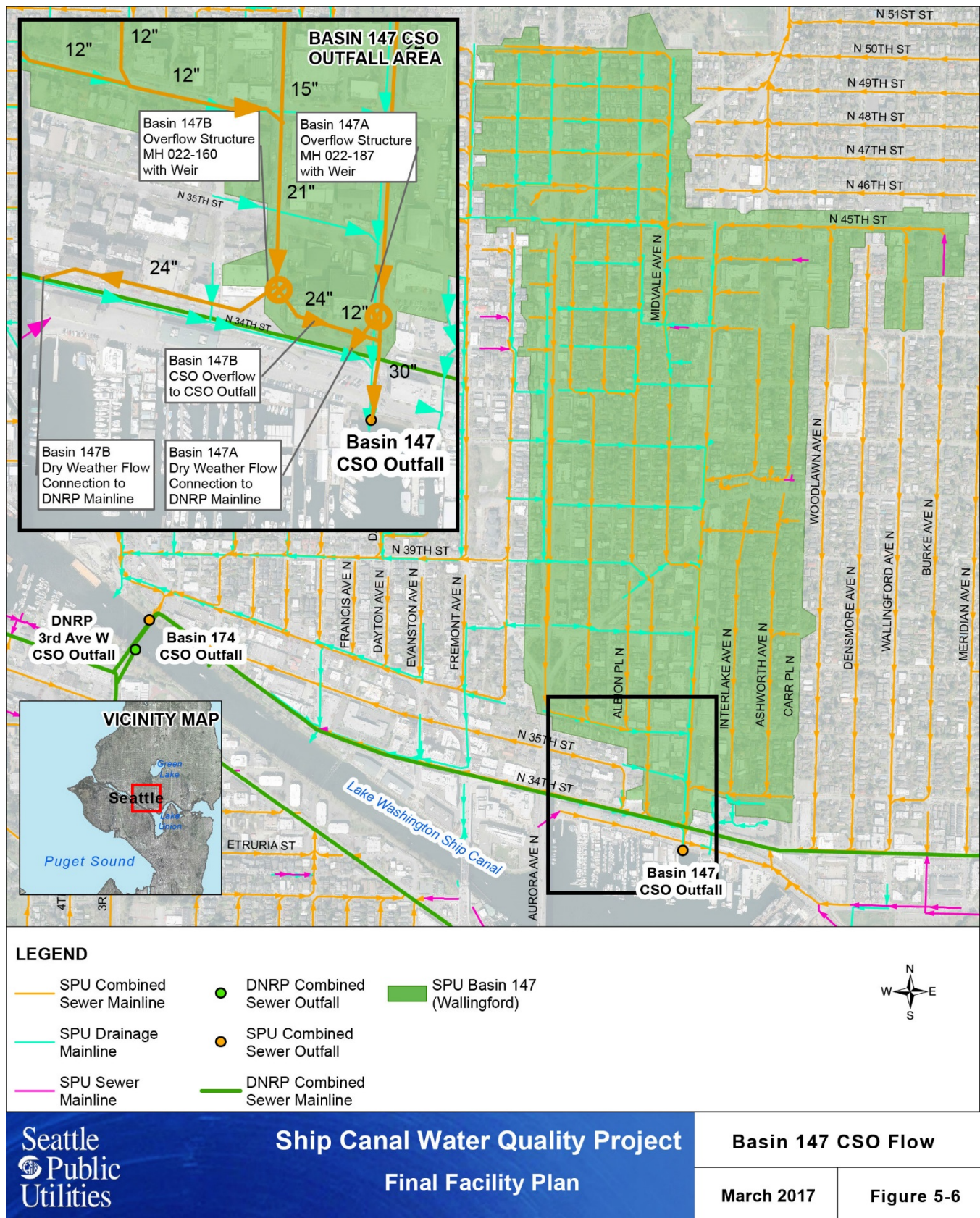


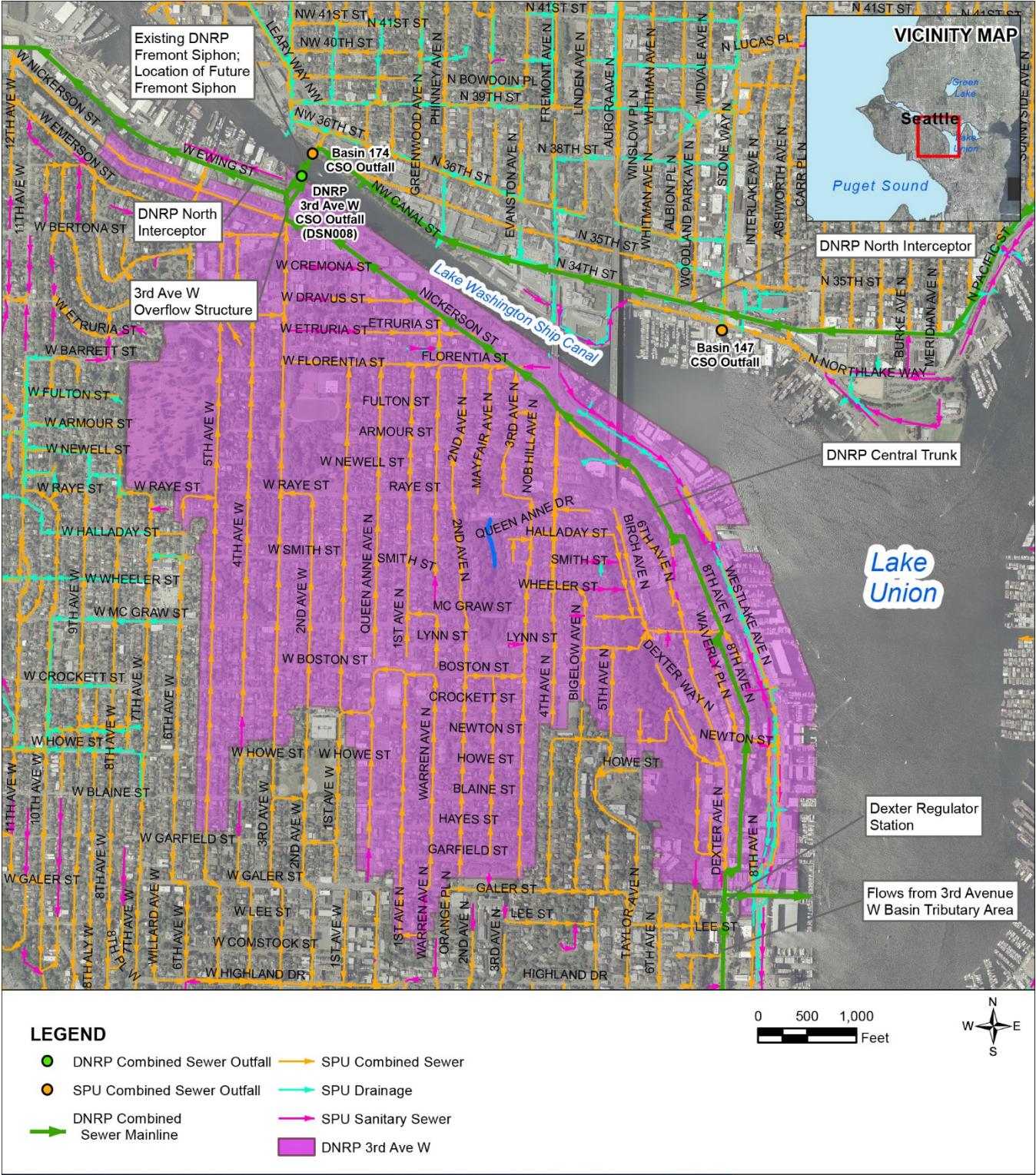












This page intentionally left blank.

6 Historical Combined Sewer System Flows

This chapter characterizes the historical combined sewer flows from the project area, which include large portions of North Seattle and CSO outfalls in the Wallingford, Fremont, Ballard, and north Queen Anne neighborhoods. SPU and DNRP have developed an understanding of sewer system flows through a combination of flow monitoring and hydraulic modeling. Together, the monitoring data and modeling results produce the information necessary to characterize system performance, understand hydraulic issues, and evaluate and design CSO control projects.

6.1 Monitored Basin Flows

Flow and level data were collected in the Ship Canal WQ Project area and used to characterize system hydraulics and calibrate hydraulic models. The monitoring program consists of permanent stations (including SCADA locations) that provide CSO discharge monitoring and assist in system operation and temporary monitoring sites that supplement the characterization of system hydraulics. Together, the permanent station data and temporary monitoring data were used to create a more robust model calibration to support the calculation of CSO control volumes. Table 6-1 lists the average dry-weather flow for each CSO area. Wet-weather flow conditions are described in the subsequent sections.

Table 6-1. Dry-Weather Flows in the Ship Canal Water Quality Project Basins

CSO Basin	Average Dry-Weather Flow (MGD)
147	0.4
174	0.6
3rd Avenue W	5.3
11th Avenue NW	5.2
150/151	0.4
152	0.9

6.1.1 Temporary Flow Monitoring

During development of the *Plan to Protect Seattle's Waterways* (SPU, 2015a), temporary flow monitors were installed in the Fremont and Wallingford neighborhoods (Basins 174 and 147) and Ballard neighborhood (Basins 150/151, and 152). The *Flow Monitoring Summary Report* (SPU, 2010b) describes the flow monitoring program for the

Fremont/Wallingford and Ballard areas and the monitoring data collected from October 2008 through May 2010. The report documents the flow data results, quality assessment, and related information. The project team used this information to develop dry-weather flows; document wet-weather influences on system flows; characterize hydraulic performance of the system, including weirs and other hydraulic structures; and calibrate and validate the hydraulic models.

DNRP used temporary flow monitoring and level data to support the Central Trunk model calibration and to estimate CSO control volumes at the 3rd Avenue W Outfall. Seven temporary meters installed in SPU and DNRP sewers were used to estimate dry-weather flows, calibrate the model's wet weather response, and estimate diversions from the Central Trunk system (tributary to the 3rd Avenue Overflow Structure) to the Denny/Lake Union Tunnel system. Temporary level monitoring data helped verify DNRP's hydraulic model calibration at the 11th Avenue NW Overflow Structure weir. This verification was part of the Ballard Regulator Station Siphon Design Project completed by DNRP in 2013.

Table 6-2 describes how the temporary flow monitors were used in the hydraulic models. Figure 6-1, Figure 6-2, Figure 6-4, and Figure 6-5 are reproduced from the hydraulic model reports (SPU, 2012a and 2012b) and show a schematic view of the monitoring locations and dry-weather flows in each basin. Figure 6-3 provides a schematic view of the temporary monitoring program in the 3rd Avenue W area. No figure is included for the 11th Avenue NW area because this model was calibrated to permanent monitoring data collected downstream at the Ballard Regulator Station.

6.1.2 No Impact Release Rate

No Impact Release Rate (NIRR) constitutes a set of time series data obtained from models, identifying available capacity at a specific point in the DNRP system after DNRP's future CSO control projects are on-line. The NIRR estimates when and how SPU can drain a storage facility or transfer captured CSOs to a specific point in the DNRP system without adversely impacting DNRP facilities. Predicted performance of the Ship Canal WQ Project was analyzed using NIRRs in SPU's *Plan to Protect Seattle's Waterways*, Volume 2: LTCP, Appendix L (SPU, 2015a).

Table 6-2. Temporary Monitoring Summary for Model Calibration

CSO Basin	Number of Temporary Flow Monitors	Flow Monitor Usage
147	8	Hydrology/hydraulic calibration = 6 Establish boundary condition = 2
174	6	Hydrology/hydraulic calibration = 5 Establish boundary condition = 1

Table 6-2. Temporary Monitoring Summary for Model Calibration

CSO Basin	Number of Temporary Flow Monitors	Flow Monitor Usage
3rd Avenue W	7	Hydrology/hydraulic calibration = 6 Characterize system operation = 1
11th Avenue NW ^a	1	Hydraulic verification at regulator = 1
150/151	4	Hydrology/hydraulic calibration = 3 Establish boundary condition = 1
152	16	Hydrology/hydraulic calibration = 13 Used to support GSI ^b analysis = 2 Establish boundary condition = 1

^a Temporary monitoring was conducted at the 11th Avenue NW Overflow Structure weir to verify the hydraulic model performance as part of the Ballard Siphon design project. The model calibration relied upon SCADA records.

^b Data from flow-monitoring equipment installed in Ballard determined the fraction of wet-weather flow entering the system from different sources (e.g., rooftops versus public right-of-way connections).

GSI = green stormwater infrastructure.

6.1.3 Permanent Flow Monitoring

SPU and DNRP operate and maintain permanent monitoring equipment to identify overflow frequency and estimate discharge volumes at each CSO outfall. SPU and DNRP report discharge duration, discharge volume, and weather-related information (precipitation and storm duration) on a monthly and annual basis, in accordance with their NPDES waste discharge permits.

The hydraulic models for each basin utilized the permanent monitoring data at the CSO structures to calibrate and/or verify the model predictions. For example, the permanent monitoring data at SPU's CSO structures were used to estimate hydraulic losses within these CSO structures and finalize the hydraulic calibration. DNRP's models used SCADA information at the 3rd Avenue Overflow Structure, 11th Avenue NW Overflow Structure, and Ballard Regulator Station (downstream of 11th Avenue NW) to support model calibration and verification and to supplement temporary monitoring data collected in the area. Figure 6-3 shows permanent flow monitoring locations for DNRP's 3rd Avenue W CSO Basin. DNRP does not have permanent flow monitoring data for the 11th Avenue NW CSO Basin.

Table 6-3 summarizes the reported CSO discharge records from 2010 through 2014 for the seven outfalls addressed by the Ship Canal WQ Project, as reported annually to Ecology. The table indicates that each outfall overflows several times per year and shows the relative CSO discharge frequency and volume among the outfalls.

**Table 6-3. Ship Canal Water Quality Project Basins
Reported CSO Frequency and Volumes 2010-2014**

Outfall	Total Number of CSO Events	Average Number of CSO Events Per Year	Average Annual CSO Volume (MG)
147	226	45.2	12.9
174	67	13.4	7.5
3rd Avenue W (DSN008)	45	9.0	8.2
11th Avenue NW (DSN004)	92	18.4	11.6
150 and 151	133	26.6	3.1
152	265	53.0	37.5
TOTAL	828	165.6	80.8

6.1.4 Rain Gauges

SPU has operated a citywide network of rain gauges since the late 1970s. Figure 6-6 shows the locations of these and DNRP's gauges and outlines of the contributing areas for each CSO outfall. Data from SPU's rain gauges 1, 7, 8, 9, 11, and 20 were used to model SPU's and DNRP's sewers in the Ship Canal WQ Project basins.

6.2 Modeled Basin Flows and Control Volumes

The hydraulic models of the Ship Canal WQ Project basins were developed and progressively refined to support the understanding of the combined sewer system, wet-weather flows, and CSO events, and then later to evaluate alternative measures for CSO control. SPU's and DNRP's modeling efforts are documented in the following reports:

1. SPU's hydraulic model reports (SPU, 2012a and 2012b) describe the development of basin models, including flow monitoring data and special hydraulic structures. The reports also cover model calibration and validation. Volume 2 (2012a) describes the Ballard model for Outfalls 150, 151, and 152, and Volume 5 (2012b) describes the Fremont and Wallingford models for Outfalls 174 and 147.
2. The *Plan to Protect Seattle's Waterways*, Volume 2: LTCP, Section 2.6 and Appendix G (SPU, 2015a) describe the long-term model simulations, uncertainty analysis, and control volumes for SPU's CSO outfalls.
3. The *Plan to Protect Seattle's Waterways*, Volume 2: LTCP, Appendix L (SPU, 2015a) describes the analysis of specific CSO control options, such as tanks and tunnels. The document includes standalone control strategies for SPU outfalls

and joint projects for SPU and DNRP outfalls. The CSO models include DNRP's no NIRRs, which are used to determine when and how storage facilities can be drained during and after storm events based on available capacity in the DNRP system, without adversely impacting DNRP facilities.

4. King County's Long-Term CSO Control Plan Amendment, Appendix B (King County, 2012a), describes the hydraulic modeling and monitoring approach to computing control volumes and evaluating CSO control options for the 3rd Avenue W and 11th Avenue NW outfalls.

The following sections summarize the modeling results, which demonstrate that the recommended project will bring the Ship Canal WQ Project basin outfalls into compliance.

Table 6-4 lists the predicted annual CSO frequency and volume and the control volume for each of the outfalls (see SPU, 2015a Appendix G and King County, 2012a for additional detail). These CSO statistics were derived from a series of 32-year simulations with calibrated hydraulic models and represent how the existing system performs under a wide variety of historical climate conditions. Each outfall experiences several CSO discharges per year.

Table 6-4. Long-Term Modeling Results (1978 to 2009): CSO Frequencies, Overflow Volumes, and Control Volumes

Outfall	Average Number of CSO Events Per Year	Average Annual CSO Volume (MG)	Control Volume (MG)
147	41.9	8.9	2.15
174	8.6	3.8	1.06
3rd Avenue W	16.8	17.5	4.18
11th Avenue NW	16.1	11.2	1.85
150 and 151	16.0	2.9	0.62
152	47.8	23.5	5.38
TOTAL	147.2	67.8	15.24

Note: The SPU control volumes account for future climate change and were identified through hydraulic modeling presented in the Plan to Protect Seattle's Waterways, Volume 2 (SPU, 2015a), with boundary conditions provided for the DNRP combined sewer conveyance system. The DNRP control volumes were presented in King County's 2012 Long-Term CSO Control Plan Amendment (King County, 2012a).

The model will continue to be updated during detailed design, and the project design will be updated as appropriate. The recommended project (see Chapter 10) is a shared SPU and DNRP deep tunnel that will store combined sewer flows from the Ship Canal WQ Project basins during large storms and return these flows to DNRP's regional

conveyance system when capacity is available. As a minimum, the tunnel storage volume will be equal to the sum of the control volumes for the Ship Canal WQ Project basins. Table 6-5 shows the estimated frequency of CSO discharges after the recommended project is implemented based on a 20-year modeled simulation (1990 to 2009) conducted with calibrated CSO models using historical rainfall data and NIRRs provided by King County (see *Plan to Protect Seattle's Waterways*, Volume 2: LTCP, Appendix L, Section 13 for additional details). The modeling results indicate the recommended project will reduce CSO frequencies to less than one per year at each outfall.

Table 6-5. Predicted CSO Frequency with Tunnel Volume Approximately Equal to the Combined Control Volumes: Based on 1990 to 2009 Rainfall

Outfall	Average Number of CSO Events Per Year
147	0.6
174	0.5
3rd Avenue W	0.5
11th Avenue NW	0.4
150 and 151	0.6
152	0.7

Note: The SPU design storage volumes account for future climate change and were identified through hydraulic modeling of the CSO control measure concepts presented in the Plan to Protect Seattle's Waterways, Volume 2, with boundary conditions provided for the DNRP combined sewer conveyance system.

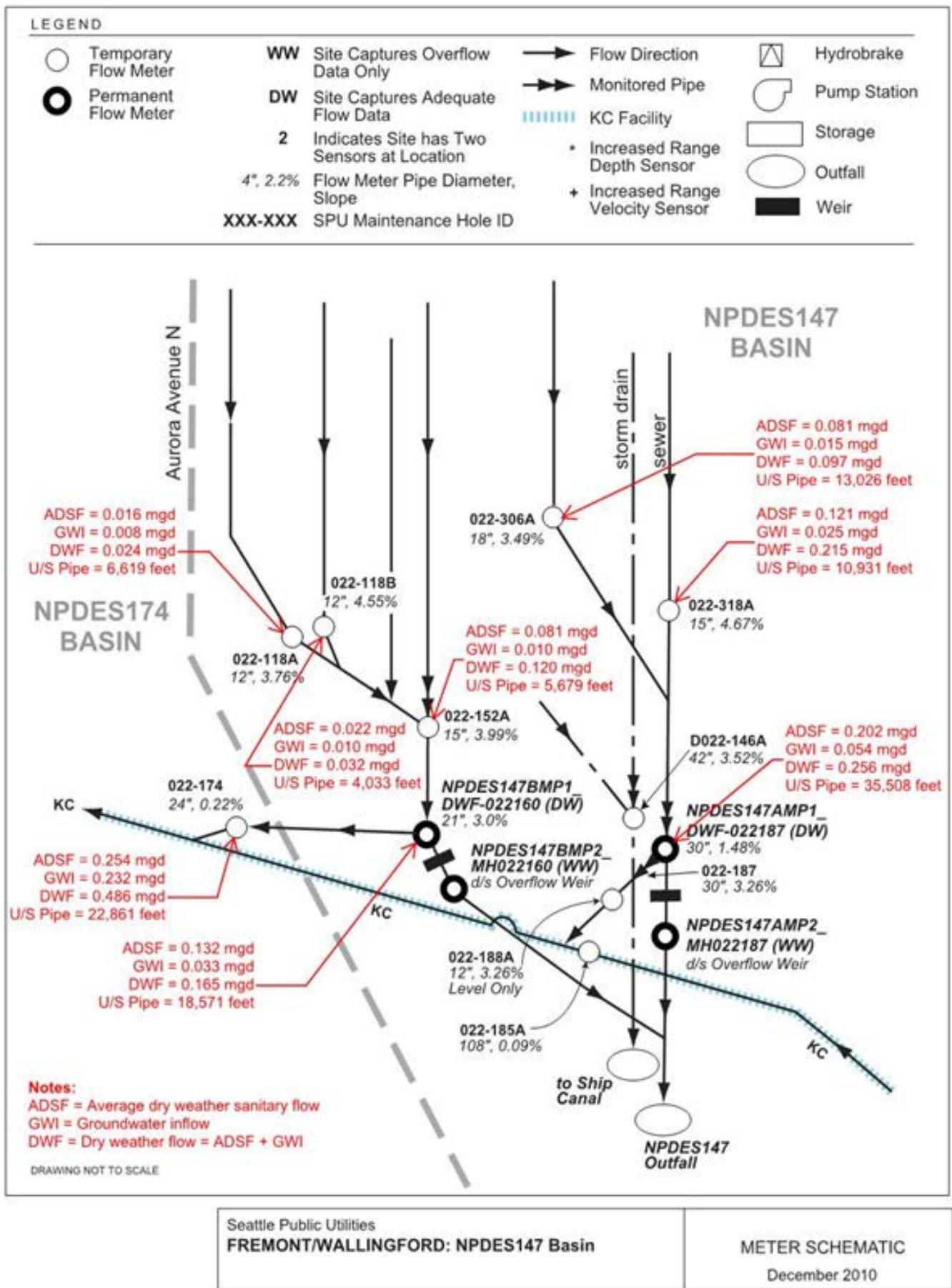


Figure 6-1. Schematic Dry-Weather Flow Summary for Basin 147

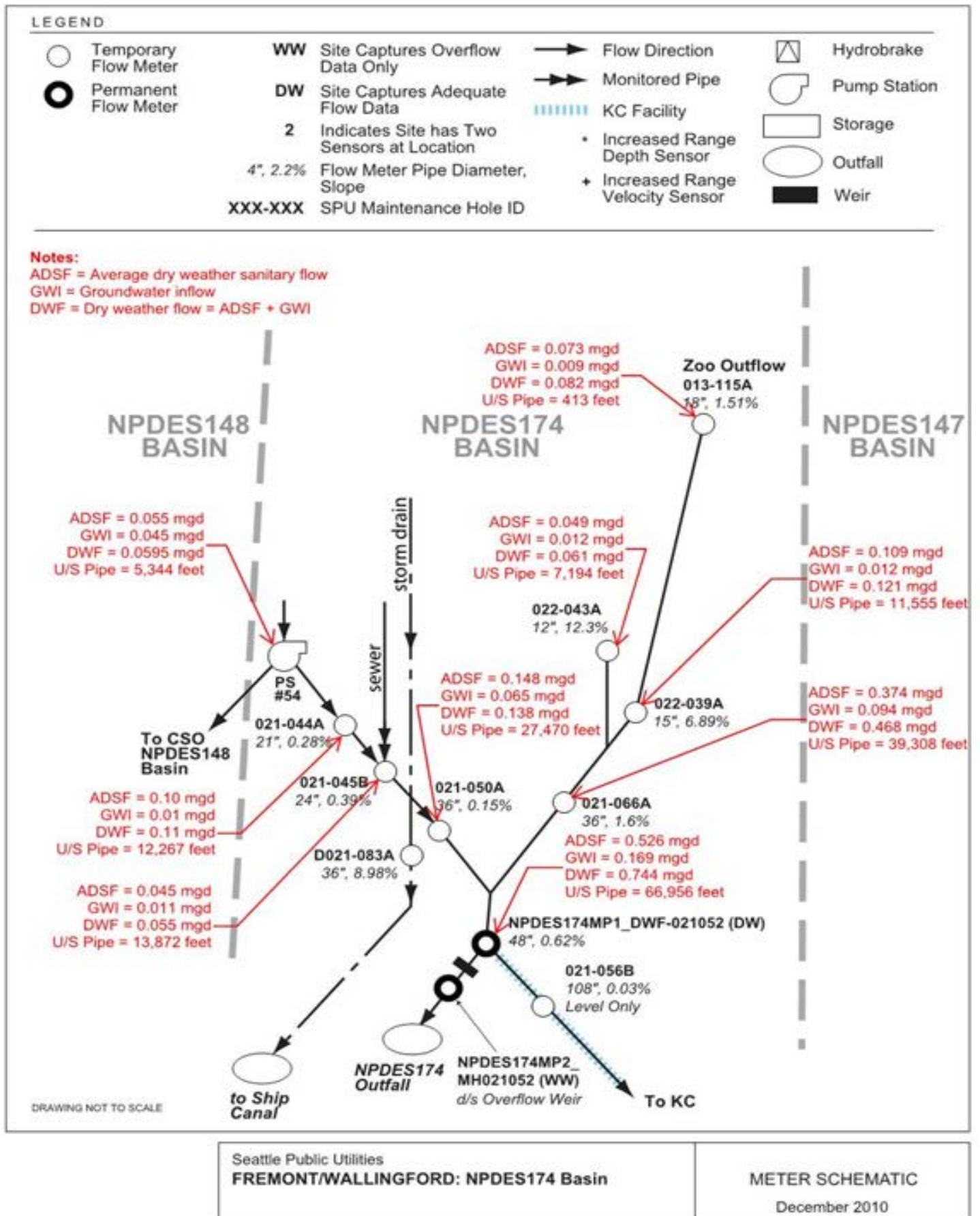


Figure 6-2. Schematic Dry-Weather Flow Summary for Basin 174

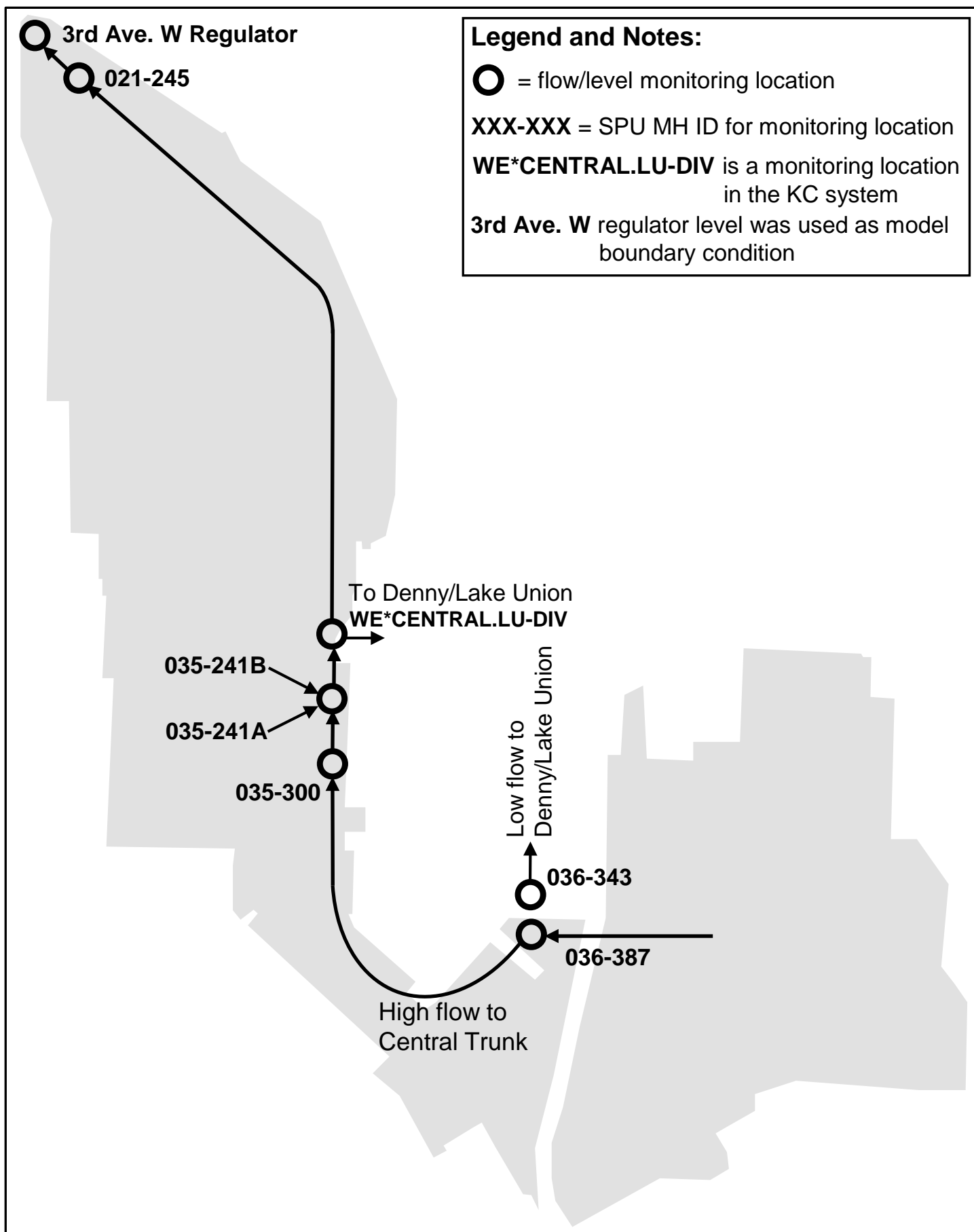


Figure 6-3. Schematic Flow Monitoring Summary for the 3rd Avenue W CSO Basin

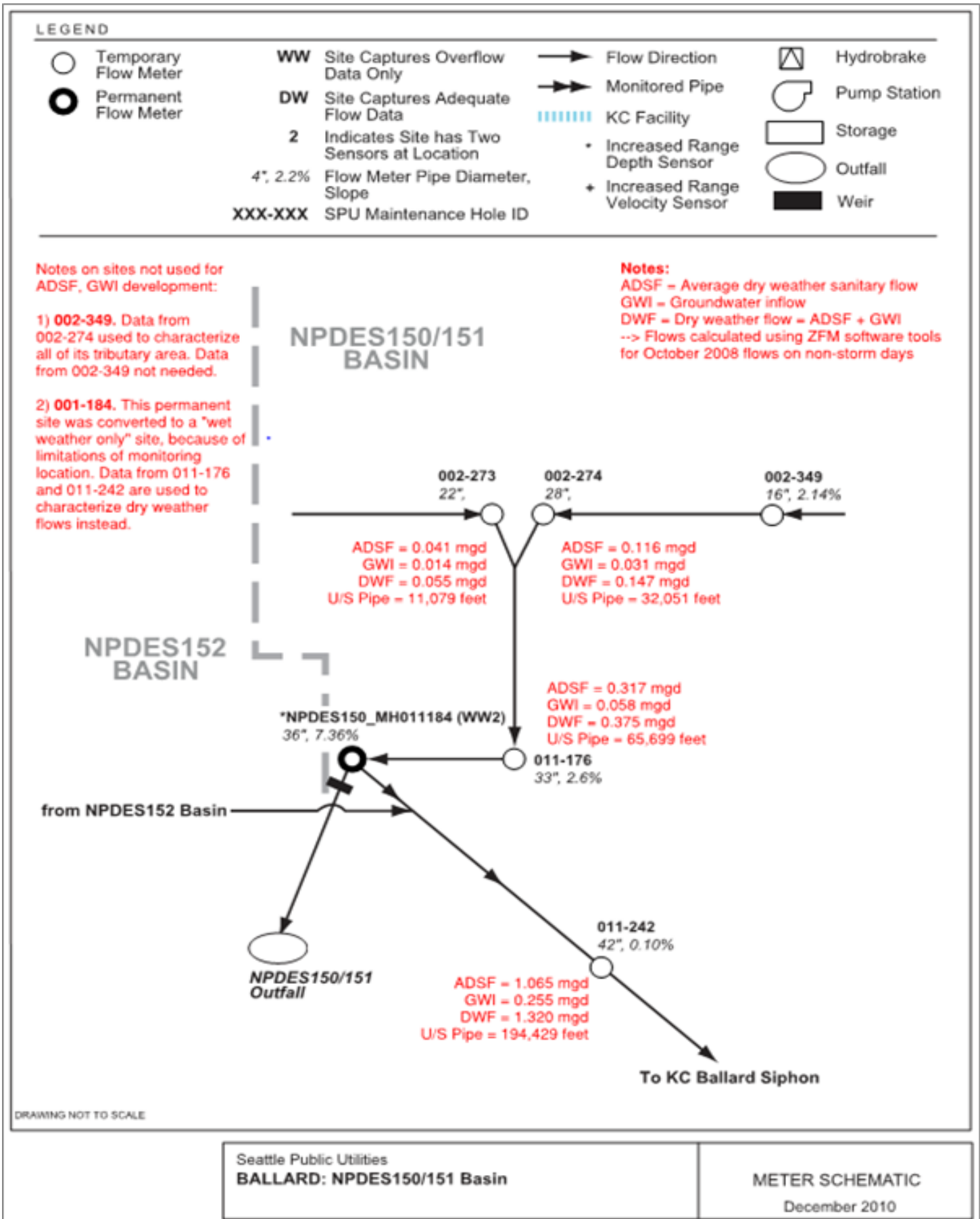


Figure 6-4. Schematic Dry-Weather Flow Summary for Basin 150/151

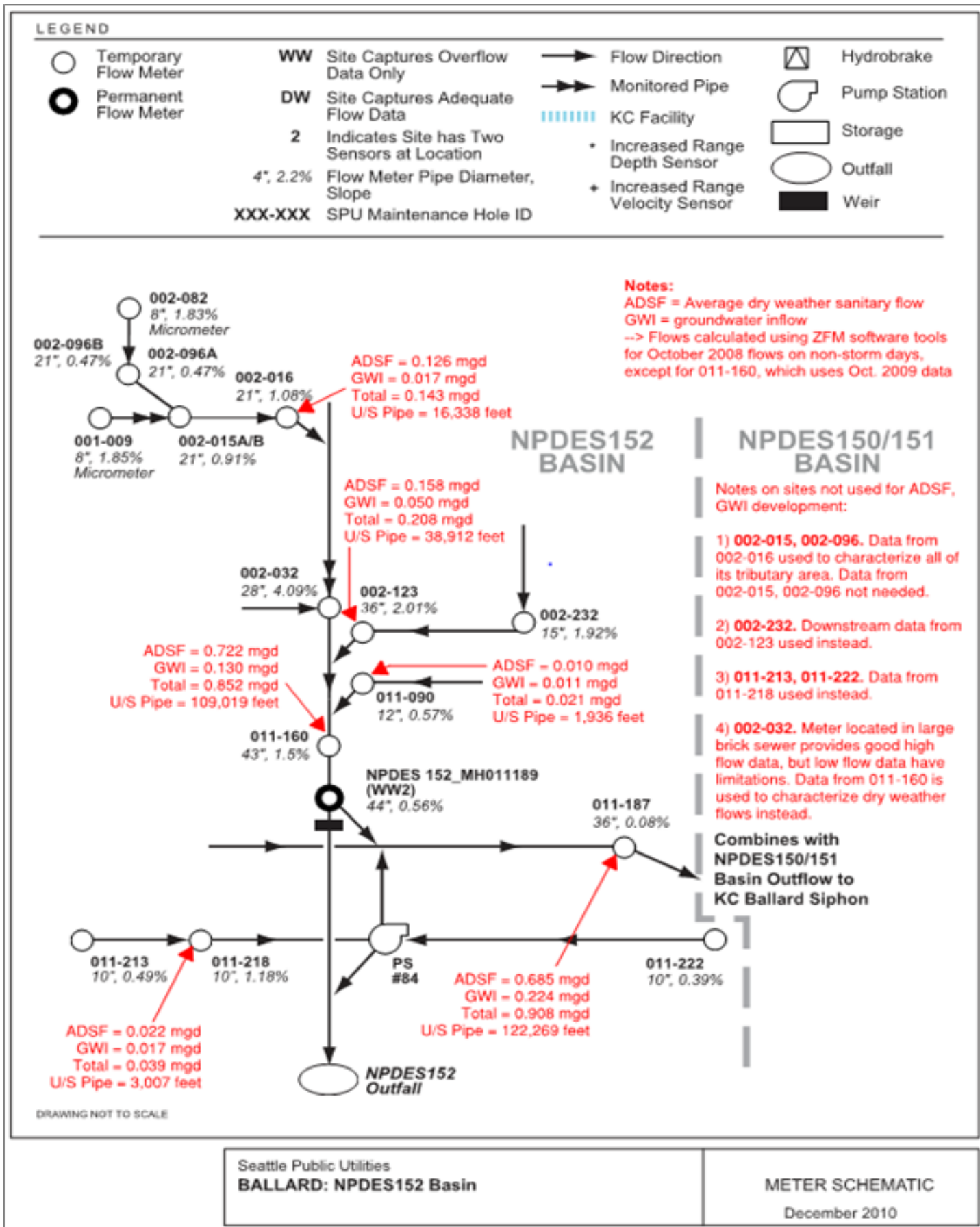
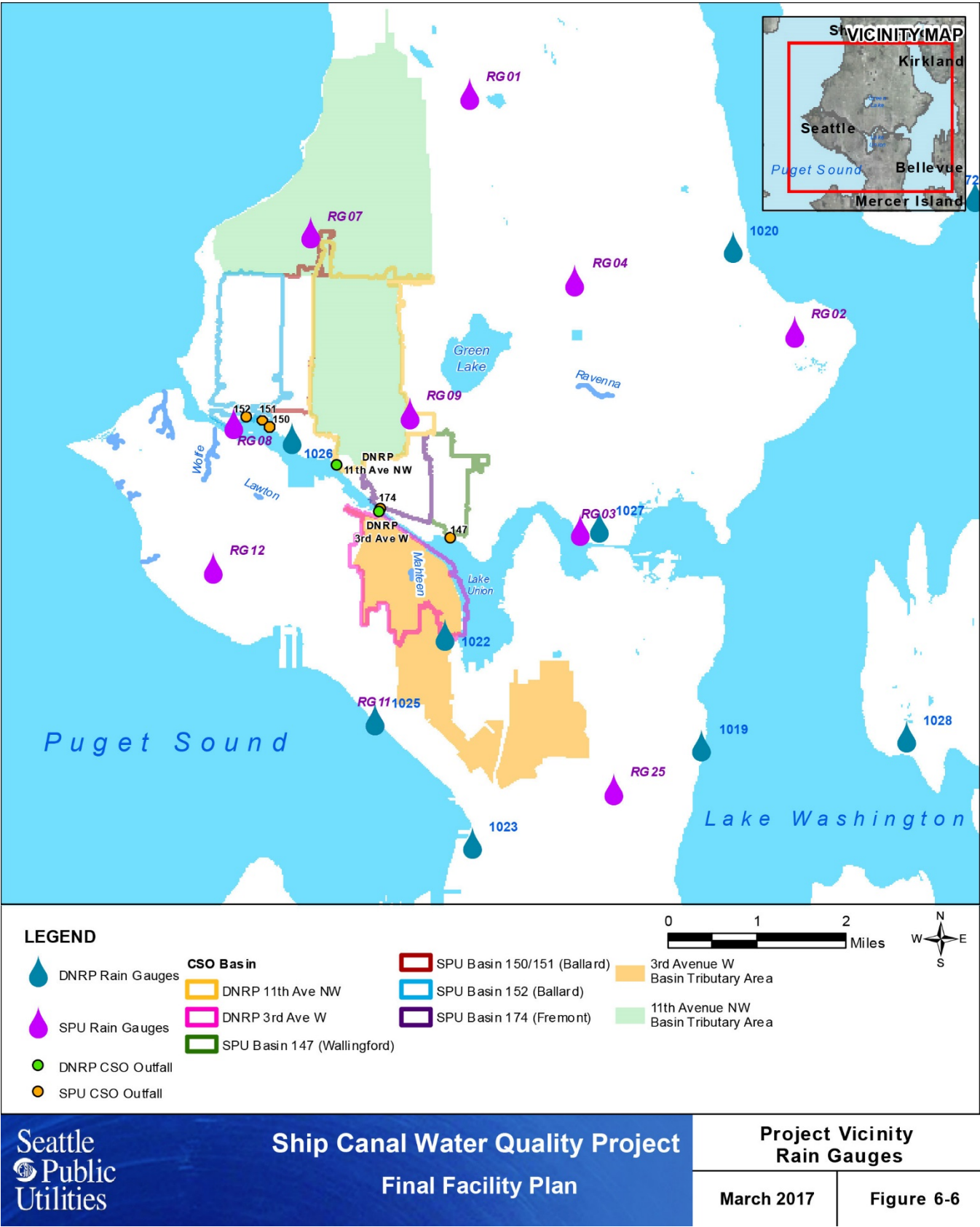


Figure 6-5. Schematic Dry-Weather Flow Summary for the Outfall 152 Basin



7 Future Conditions

This chapter describes the future conditions in the Ship Canal WQ Project basins related to land use, projected sewer flows, and other issues.

7.1 Future Demographics, Land Use, and Projected Population Levels

Based on City of Seattle Department of Construction and Inspections comprehensive and neighborhood plans, the population and land use are expected to change in the project area as redevelopment and infill projects are constructed. As the City implements its Seattle 2035 Comprehensive Plan (City of Seattle, 2015c), including focused initiatives on the urbanization of Ballard, Fremont, and Wallingford, the landscape of the community in the project area will change over time. The Ballard Interbay Northend Manufacturing Industrial Center has been the focus of planning studies currently underway by the City, and the area near the West Portal is included in the Ballard Urban Village limits. Additionally, the extension of 24th Avenue NW that lies west of the representative property proposed as the potential site for the West Portal under the recommended option (see Chapter 10) is identified as part of the “Character Cove” area in Ballard.

The City’s Department of Construction and Inspections is currently considering planned zoning changes for the basins included in the Ship Canal WQ Project, and infill and redevelopment will likely occur over time (see Figure 4-1 in Chapter 4 for current project area zoning classifications). Redevelopment could increase impervious area, but overall the development will likely reduce wet-weather inflows to the combined system because future improvements will be required to direct stormwater to storm drains rather than combined sewers. Redevelopment also may require stormwater detention, depending on the area disturbed by the project. Large-scale conversion from single-family to multifamily housing is expected in the Ship Canal WQ Project basins, with mixed-use multifamily residences replacing some industrial and commercial properties. In other parts of the planning area, new larger, single-family homes are expected to replace older, small, single-family residences. Therefore, population density is expected to increase modestly.

7.2 Projected Dry-Weather Flows

Dry-weather flows comprise sewage only and are much smaller in volume than wet-weather flows. The Ship Canal WQ Project basins are fully developed and sewered. Redevelopment and infill projects will modestly increase the future population and the

amount of sewage generated, but the increased sewage volume from future customers could be partially offset by installing efficient plumbing and other water conservation activities. Because sanitary flows represent only a small fraction of the total flow during wet-weather events, these modest changes in sanitary flows will not significantly affect the sizing of the sewer system or the Ship Canal WQ Project.

7.3 Projected Combined Sewer Overflow Frequency and Volume

The combined effects of redevelopment, population growth, climate change, and the condition of the collection system will influence the future flows in the combined system. As described above, redevelopment and associated population growth will have a negligible effect on the type of wet-weather flows that currently generate CSO discharges. Climate change and climate variability could affect hydraulic projects in the Puget Sound area due to increases in sea level and rainfall. The downstream surface water body in the Ship Canal WQ Project basins is the Lake Washington Ship Canal, which is controlled by the U.S. Army Corps of Engineers through its management of the Hiram M. Chittenden Locks. The Ship Canal water level is not expected to change under future climate scenarios.

The increase in rainfall due to climate change was incorporated into the hydraulic modeling analysis, calculation of control volumes, and the evaluation of CSO control options, including the Ship Canal WQ Project. SPU's methodology for addressing climate change and other uncertainties in CSO planning is described in the *Estimating Control Volumes for CSO Reduction: Technical Guidance Manual* (MGS Engineering Consultants, 2009). Table 6-6 in Chapter 6 showed the expected CSO frequency is between 0.4 and 0.7 event per year for the Ship Canal outfalls after the effects of climate change are considered. Therefore, the recommended option (see Chapter 10 for details) in this Facility Plan is expected to achieve initial and long-term compliance.

7.4 Future Flow Reduction Options

Chapters 8 and 9 discuss the various flow reduction options and those options previously evaluated by SPU and DNRP. Chapter 10, 11, and 12 describe the recommended option in further detail.

8 Options Development and Evaluation

The information in this chapter is a summary of the options development and evaluation process completed in 2013 during preparation of the Draft SPU LTCP (Volume 2 of the *Plan to Protect Seattle's Waterways*; SPU, 2014a). The chapter generally describes the process SPU and DNRP used to develop and evaluate options for controlling CSO outfalls in the project area.

8.1 Overview

The process to develop and evaluate options for addressing CSOs in the project area included the following steps:

- Step 1 – Identified and evaluated high-level CSO control strategies.
- Step 2 – Developed and evaluated storage options.
- Step 3 – Developed and evaluated storage themes (independent versus joint).
- Step 4 – Evaluated highest-ranking options to select recommended option.
- Step 5 – Refined recommended option.

8.2 Identified and Evaluated High-Level Combined Sewer Overflow Control Strategies

During development of SPU's LTCP, Volume 2 of the *Plan to Protect Seattle's Waterways* (SPU, 2015a) and King County's October 2012 Long Term CSO Control Plan Amendment (King County, 2012a), major high-level categories of CSO control strategies as listed by EPA guidance documents were evaluated. SPU built upon the analysis work that was performed as part of developing the City's *2010 CSO Reduction Plan Amendment* (SPU, 2010a). CSO control measures that were screened out as part of the 2010 Plan were not evaluated further. Strategies that were analyzed included the following

- Collection system controls, including sewer system improvements (retrofits), sewer separation, flow diversion, and infiltration/inflow control
- Source controls, including GSI
- Storage technologies, including offline and in-line storage

- Treatment technologies, providing treatment of CSOs prior to discharge (DNRP only)
- Refining, evaluating, and screening the range of categories of CSO control strategies resulted in a trend toward using storage technologies as the likely solution for most basins.

8.3 Developed and Evaluated Options

Conceptual CSO control options utilizing storage were developed and evaluated in preparing the SPU LTCP (SPU 2015a) and the King County Long Term CSO Control Plan Amendment (King County, 2012a). Each agency developed independent and joint (i.e., seeking to control both DNRP and SPU outfalls) options in the Ship Canal WQ Project basins. Although GSI and sewer system improvement projects were evaluated in parallel with CSO control storage options, the storage options at this conceptual phase were conservatively sized, so they do not account for any reduction in control volume from implementation of the GSI or retrofit projects.

SPU's LTCP (SPU, 2015a) and DNRP's Long Term CSO Control Plan Amendment (King County, 2012a) evaluated conceptual CSO control options for costs, technical feasibility, and community impacts using a multiple-objective decisions analysis, or triple-bottom-line analysis, that rated the options.

The following CSO control options were chosen for further evaluation by DNRP in order to pick recommended options in its October 2012 Long Term CSO Control Plan Amendment (King County, 2012a):

- Independent, additional conveyance pipe to Ballard Siphon to control the 11th Avenue NW area
- Independent offline storage tank to control the 11th Avenue NW area
- Independent, additional conveyance to control the 11th Avenue NW area
- Independent offline storage tank to control the 3rd Avenue W area
- Joint storage tank with SPU to control the 3rd Avenue W area and SPU Basins 60, 147, and 174

For the Ship Canal WQ Project basins, the following CSO control options were chosen for further evaluation by SPU in its LTCP (SPU, 2015a). SPU developed a joint tunnel option (Shared West Ship Canal Tunnel) and asked DNRP to participate in it:

- Independent offline storage tank to control Ballard Basins 150/151, and 152
- Independent offline storage tank to control Wallingford Basin 147 and Fremont Basin 174
- Independent West Ship Canal Tunnel to control Basins 147, 150/151, 152, and 174

- Shared West Ship Canal Tunnel to control Basins 147, 150/151, 152, 174, and the DNRP 11th Avenue NW and 3rd Avenue W areas

8.4 Evaluated Highest-Ranking Options to Select Recommended Option

The agencies conducted a final evaluation of the combination of projects (highest-ranking options) summarized in Table 8-1 and documented in SPU's Final Plan (SPU, 2015a). This evaluation assisted in the decision on whether the Ship Canal WQ Project will be a shared or an independent SPU project. In preparation for this final evaluation, detailed cost estimates for each project were prepared for a more accurate comparison.

Table 8-1 Highest-Ranking Options Comparison

Option No.	Option Components	Type of CSO Control	Area	Owner	Basins
1	Independent Tanks and Flow Transfer Projects	Storage Tank	Ballard	SPU	150/151
			Ballard	SPU	152
		Storage Tank	Wallingford	SPU	147
			Fremont	SPU	174
		Storage Tank	3rd Avenue W	DNRP	3rd Avenue W
		Flow Transfer	11th Avenue NW Overflow Structure	DNRP	11th Avenue NW
2	Independent SPU Tunnel	Storage Tunnel	Ballard	SPU	150/151
			Ballard	SPU	152
			Wallingford	SPU	147
			Fremont	SPU	174
	DNRP 3rd Avenue W Tank	Storage Tank	3rd Avenue W	DNRP	3rd Avenue W
	DNRP 11th Avenue NW Increased Conveyance	Flow Transfer	11th Avenue NW Overflow Structure	DNRP	11th Avenue NW
3	Shared Ship Canal Water Quality Project (Shared SPU and DNRP Tunnel)	Storage Tunnel	Ballard	SPU	150/151
			Ballard	SPU	152
			Wallingford	SPU	147
			Fremont	SPU	174
			3rd Avenue W	DNRP	3rd Avenue W
			11th Avenue NW Overflow Structure	DNRP	11th Avenue NW

The Ship Canal WQ Project was selected based on financing, scheduling, community impacts, regulatory considerations, and lead agency designation and responsibilities. Each factor is summarized below and documented in SPU's Final Plan (SPU, 2015a).

8.4.1 Financing

In accordance with agreed-upon principles, financial benefits are to be shared by both agencies. Benefits will be realized through economies of scale and other efficiencies from replacing a larger number of independently designed and constructed storage projects with one jointly developed storage project. A planning-level, conceptual, present value of cost evaluation (using cost data with expected -20 percent to +30 percent accuracy) for the three options in Table 8-1 yielded present values that are similar, taking into account the overlap in accuracy range of the costs. Thus, cost is not a distinguishing difference between the options. See Table 9-1 in Chapter 9 for a summary of the highest-ranking options costs.

8.4.2 Joint Project Benefits

King County's participation as a partner with the City of Seattle on the Ship Canal Project has been approved and documented by modification of the compliance schedule in its Consent Decree with DOJ, EPA, and Ecology, filed October 25, 2016, with the United States District Court, Western District of Washington (United States of America, 2016). The Ship Canal WQ Project will be completed sooner than an independent project serving the 11th Avenue NW area, providing earlier water quality benefits as well as an opportunity for the agencies to improve system coordination.

8.4.3 Community Impacts

Compared with multiple independent projects, the Ship Canal WQ Project concentrates major construction in fewer locations, require less property acquisition, and allow greater repurposing of acquired property than the independent projects.

8.4.4 Regulatory Considerations

The joint Ship Canal WQ Project offers the capability of greater flexibility to control the outfalls in the project area, because the larger storage volume can be used to optimize storage for each basin depending on variability of rainfall and flows in each basin. The Ship Canal WQ Project will be operated based on system flows, levels, and predictive rainfall forecasts that are simulated in a hydraulic and hydrologic model to optimize gate and other flow settings.

8.4.5 Lead Agency Designation and Responsibilities

SPU will be the lead agency for planning, designing, constructing, owning, and operating the Ship Canal WQ Project. Both agencies have recent experience with constructing storage facilities, and DNRP operations staff can bring expertise and valuable input on operation of facilities during project planning, design, and operations.

8.5 Refining Recommended Option

The recommended option underwent additional refinement related to engineering, financial analysis, and assessment of environmental impacts. Chapters 10, 11, and 12 document those refinements.

8.6 Options Modeling

During the options development, an EPA SWMM system model was used to analyze the hydraulics of the proposed improvements, establish sizing criteria for the interception structures and conveyance, and validate the effectiveness of the proposed options for the Ship Canal WQ Project basins.

8.6.1 Options Modeling Methodology

The hydraulic models of the Ship Canal WQ Project basins were developed and progressively refined to support the understanding of the combined sewer system, wet-weather flows and CSO events, and then later to evaluate option measures for CSO control. For more information on modeling methodology, refer to Chapter 6.

8.6.1.1 Base Conditions

Tables 6-4 and 6-5 in Chapter 6 summarize the predicted CSO frequency and associated control volume at each outfall, based on the results of the long-term simulations using historical rainfall data.

8.6.1.2 Boundary Conditions

The boundary conditions determined by DNRP for the Ship Canal WQ Project basins included the following conditions, which are independent of each other:

- Hydraulic grade line at DNRP interceptors prepared by DNRP using long-term simulations; boundary conditions applied by the Ballard Siphon, MH022-184, MH022-178 (Outfall 147), and MH021-056 (Outfall 174)
- Hydraulic grade lines at outfalls based on the Ship Canal water levels as measured by the U.S. Army Corps of Engineers at the Locks.

8.6.2 Options Modeling Results

The options were modeled using the Ship Canal WQ Project SWMM model. Refer to Chapter 6, Tables 6-4 and 6-5, for long-term simulation results for implementation of the Ship Canal WQ Project.

9 Evaluation of Highest-Ranking Options

The information in this chapter is a summary of the options evaluation completed in 2014 during preparation of the SPU LTCP (Volume 2 of the *Plan to Protect Seattle's Waterways*; SPU, 2015a). The chapter provides high-level summary engineering, cost, and environmental information for the three highest-ranking options that were evaluated for achieving CSO reduction and regulatory compliance in SPU Basins 152, 150/151, 147, 174, and the DNRP 11th Avenue NW and 3rd Avenue W combined sewer areas. These options were developed as described in Chapter 8 and include individual basin CSO control strategies and larger multi-basin CSO control strategies developed as part of the SPU LTCP and King County CSO Control Plan Amendment (King County, 2012a). The three highest-ranking options identified in SPU's LTCP are as follows:

- Option 1: Independent Tanks and Flow Transfer
- Option 2: Independent SPU Tunnel and DNRP Tanks and Flow Transfer
- Option 3: Shared SPU and DNRP Tunnel

Table 9-1 summarizes the total capital, O&M, and life-cycle replacement costs for the three highest-ranking options. Replacement costs include major electrical and mechanical equipment replacement on specified (e.g., 5-, 10-, 25-year) replacement intervals for a 100-year facility service life. All costs presented in Table 9-1 are in 2014 present value dollars. Total project costs for the recommended option are presented in Tables 11-1. Updated O&M and replacement costs for the recommended option are presented in Tables 11-2 and 11-3.

9.1 Combined Sewer Overflow Options

9.1.1 Option 1: Independent Tanks and Flow Transfer

The Independent Tanks and Flow Transfer option is shown in Figure 9-1. The main system components of this option include:

- **SPU Ballard Tank**—A new 6.0-MG underground offline storage tank located in Ballard to control CSOs from Outfalls 150, 151, and 152; associated control structures and conveyance pipes; and buried facility vault electrical and mechanical equipment.

Table 9-1. Capital, O&M, and Life-Cycle Present Value Costs for the Highest-Ranking Options

Option	Total Present Value (2014 Dollars) ^a	Estimated Capital Present Value Cost (2014 Dollars) ^b	O&M Present Value Cost (2014 Dollars) ^c	Replacement Present Value Cost (2014 Dollars) ^d
1. Independent Tanks and Flow Transfer^e	\$318,800,000	\$282,500,000	\$20,600,000	\$15,700,000
SPU Ballard Tank	\$116,400,000	\$106,900,000	\$6,800,000	\$2,700,000
SPU Fremont/Wallingford Tank	\$96,800,000	\$82,100,000	\$5,200,000	\$9,500,000
DNRP 3rd Avenue W Tank	\$82,700,000	\$72,400,000	\$7,600,000	\$2,700,000
DNRP 11th Avenue NW Flow Transfer (increased conveyance)	\$22,900,000	\$21,100,000	\$1,000,000	\$800,000
2. Independent SPU Tunnel and DNRP Tanks and Flow Transfer^e	\$396,800,000	\$370,800,000	\$18,600,000	\$7,900,000
Independent SPU Tunnel	\$291,700,000	\$277,300,000	\$10,000,000	\$4,400,000
DNRP 3rd Avenue W Tank	\$82,700,000	\$72,400,000	\$7,600,000	\$2,700,000
DNRP 11th Avenue NW Flow Transfer (increased conveyance)	\$22,400,000	\$21,100,000	\$1,000,000	\$800,000
3. Shared SPU and DNRP Tunnel^e	\$326,000,000	\$304,400,000	\$14,700,000	\$6,900,000

^a Present value was calculated using a discount rate of 3%. 100 years O&M and replacement.

^b Construction costs are presented based on an Association for the Advancement of Cost Engineering International (AACEI) Class 4 (-20%/+30% range) cost estimate developed parametrically from similar CSO storage tank and wastewater tunneling projects constructed in Puget Sound. Capital cost includes construction cost, soft costs, acquisition costs, if any, and reserves for contingency and management.

^c Present value was calculated using a discount rate of 3%; based on 100 years of annual O&M costs.

^d Present value was calculated using a discount rate of 3%; replacement costs include major electrical and mechanical equipment replacement on specified (e.g., 5-, 10-, 25-year) replacement intervals for a 100-year facility service life.

^e Option totals shown in bold; option component subtotal, as applicable, shown below in plain text.

- **SPU Fremont/Wallingford Tank**—A new 3.3-MG underground offline storage tank located in Wallingford to control CSOs from Outfalls 147 and 174, associated

structures and conveyance pipes, and buried facility vault electrical and mechanical equipment.

- **DNRP 3rd Avenue W Tank**—A new 4.18-MG underground offline storage tank located south of the Ship Canal near the existing DNRP 3rd Avenue W Overflow Structure to control CSOs from DNRP's 3rd Avenue W CSO, associated structures and conveyance pipes, and buried facility vault electrical and mechanical equipment.
- **DNRP 11th Avenue NW Flow Transfer**—A new 3,200-foot, 84-inch-diameter conveyance pipeline and modified diversion structure located in Ballard to transfer flows from DNRP's 11th Avenue NW CSO to the Ballard Regulator Station to reduce overflows at the 11th Avenue NW CSO, and GSI as needed.
- **Modifications to Existing System**—Modifications of existing overflow structures for SPU and DNRP, primarily weir reconstruction or adjustment.

9.1.2 Option 2: Independent Seattle Public Utilities Tunnel and King County Department of Natural Resources and Parks Tanks and Flow Transfer

The Independent SPU Tunnel and DNRP Tanks and Flow Transfer option is shown in Figure 9-2. The main system components of this option include:

- **Independent SPU Tunnel and Pump Station**—A minimum 9.21-MG, 14,000-foot-long offline storage tunnel constructed primarily in public right-of-way and extending from the West Portal in Ballard to the East Portal in Wallingford, with a 28-MGD pump station and conveyance to drain the tunnel, odor control, self-cleaning systems, and backup power.
- **Drop Shafts and Intermediate Portals**—Finished facilities located along the tunnel alignment providing conveyance functions and tunnel access. Located at key points along the alignment, drop shafts convey overflows from the targeted CSO basins from near-surface conveyance pipelines downward into the storage tunnel.
- **Conveyance**—Diversion/control structures, gravity sewer to convey flows to the storage tunnel, and pump station force mains to convey flows back to the SPU local sewer and ultimately to DNRP's conveyance system and on to West Point Treatment Plant.
- **DNRP 3rd Avenue W Tank**—A new 4.18-MG underground offline storage tank located south of the Ship Canal near the existing DNRP 3rd Avenue W Overflow Structure to control CSOs from DNRP's 3rd Avenue W CSO, associated structures and conveyance pipes, and buried facility vault electrical and mechanical equipment.
- **DNRP 11th Avenue NW Flow Transfer**—A new 3,200-foot, 84-inch-diameter conveyance pipeline and modified diversion structure located in Ballard to transfer flows from DNRP's 11th Avenue NW CSO to the Ballard Regulator Station to reduce overflows at the 11th Avenue NW CSO, and GSI as needed.

- **Modifications to Existing System**—Modifications of existing overflow structures for SPU and DNRP, primarily weir reconstruction or adjustment.
- **DNRP 3rd Avenue W Tank**—The same control measure for the DNRP 3rd Avenue W CSO basin described in Section 9.1.1.
- **DNRP 11th Avenue NW Flow Transfer**—The same control measure for the DNRP 11th Avenue NW CSO basin described in Section 9.1.1.

9.1.3 Option 3: Shared Seattle Public Utilities and King County Department of Natural Resources and Parks Tunnel

The Shared SPU and DNRP Tunnel option is shown in Figure 9-3. The main system components of this option include:

- **Storage Tunnel**—A 14,000-foot-long storage tunnel following the same alignment and including the same general features as the Independent SPU Tunnel described in Section 9.1.2. However, the shared tunnel storage capacity requirement increases to a minimum of 15.24 MG under this option and the pump station capacity increases to 32 MGD.
- **Drop Shafts and Intermediate Portals**—Finished facilities located along the tunnel alignment providing conveyance functions and tunnel access; the same as those described in Section 9.1.2, with the addition of a drop shaft at DNRP's 11th Avenue NW CSO.
- **Conveyance**—SPU Outfalls 150, 151, 152, 147 and 174, and pump station force main. Additional conveyance includes pipelines connecting overflows from DNRP's 3rd Avenue W CSO and 11th Avenue NW CSO to the tunnel.
- **Modifications to Existing System**—Modifications of existing overflow structures for both SPU and DNRP, primarily weir reconstruction or adjustment.

9.2 Environmental Impacts

SPU evaluated the environmental impacts for the three highest-ranking options as part of the Final Plan EIS (SPU, 2014b). The Final Plan EIS discloses the potential construction and operational impacts associated with the implementation of the Ship Canal WQ Project as part of the Long Term Control Plan Alternative. The Final Plan EIS looked at four options to control the remaining 22 CSO outfalls and meet regulatory requirements. With respect to the Ship Canal WQ Project, two options examined in the Final Plan EIS included the following:

- **Neighborhood Storage Option**—Similar to Option 1: Independent Tanks and Flow Transfer described in this chapter, the Final Plan EIS evaluated impacts of projects that use tanks/pipes, and a combination of a tunnel and tanks/pipes.

- **Shared Ship Canal Tunnel Option**—Similar to Option 3: Shared SPU and DNRP option described in this chapter, the Final Plan EIS evaluated impacts for a joint project between SPU and DNRP for storage of flows from the Ship Canal WQ Project CSO area.

Impacts were evaluated at a programmatic level to provide a comprehensive evaluation of potential impacts and mitigation associated with implementation of the Plan.

Site-specific impacts for the recommended option identified in Section 9.4 are presented in detail in Section 10.22 of this Facility Plan and the Final SEIS (SPU, 2017).

9.3 Public Involvement

SPU considered impacts to the public at each phase of the site selection process and during development and evaluation of the options discussed in Chapter 8.

The objective of public involvement and the Draft SEIS (SPU, 2016) review for the project is to help ensure that SPU considers and addresses concerns by the following:

- Disclosing and managing the temporary and long-term impacts to the public associated with the CSO control options
- Informing and educating the public about the need for the project, options considered, possible solutions, and how the project could affect them
- Obtaining public feedback on options and potential decisions
- Responding to questions and concerns raised by the public

Public involvement documentation for the project is included in Appendix B.

9.4 Recommended Option

The Shared SPU and DNRP Tunnel option (Option 3) was found to be comparable in cost to other options to control CSOs. While the joint storage tunnel was similar in cost to the independent storage tanks/flow transfer option (Option 1), the difference was not significant, especially given the accuracy and uncertainty of the cost-estimating range for these projects. The Independent SPU Tunnel and DNRP Tanks and Flow Transfer option (Option 2) was found to have significantly higher present value costs than either Options 1 or 3 (see Table 9-1). Another factor used to remove Option 2 from further evaluation, was eliminating added construction and operational impacts to the community associated with an independent tunnel and independent DNRP projects at 3rd Avenue W CSO and 11th Avenue NW CSO provided under Option 3.

Within the range of cost estimate uncertainty, Options 1 and 3 were comparable in cost and were further evaluated using a TBL analysis approach. TBL is an economic analysis technique that evaluates the financial, social, and environmental costs, benefits, and

risks of each option. When viewed with greater attention toward the nonmonetized considerations, such as community disruption from construction, the number of significant construction sites required, length of conveyance required for other non-tunnel options, cost-risk, and the flexibility of future expansion of the tunnel, the Shared SPU and DNRP Tunnel option offers advantages over independent tank-based storage/flow transfer and was the clear highest-ranking option. Table 9-2 lists these advantages.

Table 9-2. Shared SPU and DNRP Tunnel Option Advantages over Independent Tanks/Flow Transfer Options^a

Project Aspect	Project Benefit
Community and Political Impacts	Potential for greater political support because of lower community impacts and more favorable TBL result.
Work plan and contracting strategy	Accommodates flexible packaging that optimizes work and risk allocation to design and construction contractors, while meeting organization cash flow objectives
Real estate and right-of-way acquisition	Lower risk because less surface area/property acquisition is required and major property acquisition is already in progress, avoiding the additional siting and acquisition required by independent tank-based storage
Demolition and clearing	Lower risk because of smaller site footprints and shorter length of open-cut conveyance
Site remediation	Lower risk because of smaller site footprints and shorter length of open-cut conveyance
Utility relocation and protection	Lower risk because of smaller site footprints and shorter length of open-cut conveyance
Site excavation and excavation support	Lower risk because of smaller excavations/structures and greater separation from existing structures and infrastructure
Storage structure construction	Readily designed and constructed using proven configurations and methodologies adopted from other successful tunnel projects
Conveyance system construction	Opportunity to route a portion of the tunnel effluent conveyance pipeline within the tunnel bore, further reducing open-cut pipeline construction impacts ^a
Instrumentation and control and SCADA	Simpler integration and operational control strategies afforded by aggregation of storage into a single, centralized facility; ease of operation afforded by centralized versus spatially distributed, multiple storage facilities

^a The effluent conveyance piping alignment has changed. This project benefit is no longer part of the recommended alternative.

An important consideration for the recommended option was the tunnel alignment. This tunnel alignment was selected by SPU after considering the required tunnel endpoints

and available properties for permanent facilities, and in consideration of locating the tunnel to the maximum extent practicable along public rights-of-way.

To evaluate the nonmonetized factors, such as social and environmental objectives, several criteria were developed and defined. Table 9-3 defines ten criteria, along with the subcriteria, against which Options 1 and 3 were compared.

Table 9-3. Nonmonetized Evaluation Criteria

Main Criteria	Subcriteria
1. Technical complexity and performance risk	Does implementation require complex overall system controls? How many individual CSO facilities are needed to implement control strategy? How does the King County no-impact release rate affect City CSO operations?
2. Flexibility	Can the option meet changing control criteria and flow conditions?
3. Constructability	Are construction risks associated with the option significant? What are the expected permitting, regulatory, and land use compliance complexities, and how difficult is it expected to be to obtain permits and approvals?
4. Consent Decree compliance schedule	Does the option meet the City Consent Decree construction completion milestone date of December 31, 2025? Does the shared option meet the King County Consent Decree dates for the 3rd Avenue W and 11th Avenue NW CSO projects?
5. King County concurrence on shared projects	Has King County indicated their concurrence or objections to shared options to the City?
6. Construction impacts (short-term)	What level of disruption will occur? Are the cumulative construction impacts significant?
7. Community impacts (long-term)	Can the facility be designed to be compatible with the community? How will O&M activities impact the community?
8. Environmental and social justice	What are the option's overflow and operation impacts and benefits? Does the alternative result in unequal impacts and benefits to historically underserved communities and low-income populations during construction or operation of the facility?
9. Environmental	Will the construction impact wetlands, streams, shorelines, habitats, or endangered species?
10. Ease of O&M and safety	What level of staffing is required for operation and shutdown (how often is the facility used, how long is the facility in use, how many operators are required, what level of operator experience is required, what are travel times)? What are peak staff required? Does the facility have access requirements in the right-of-way or require confined space entry? Are traffic control procedures required? Does access require a street use permit or lane closure?

Shared SPU and DNRP Tunnel (Option 3) outperformed Independent Tanks and Flow Transfer (Option 1) in eight of the ten criteria, scored the same for criteria (8—Environmental/Social Justice) and fared worse in only one criteria (4—Consent Decree Compliance Schedule). Table 9-4 below details how the two options fared against each other according to the nonmonetized criteria.

Table 9-4. Nonmonetized Evaluation of Options 1 and 3

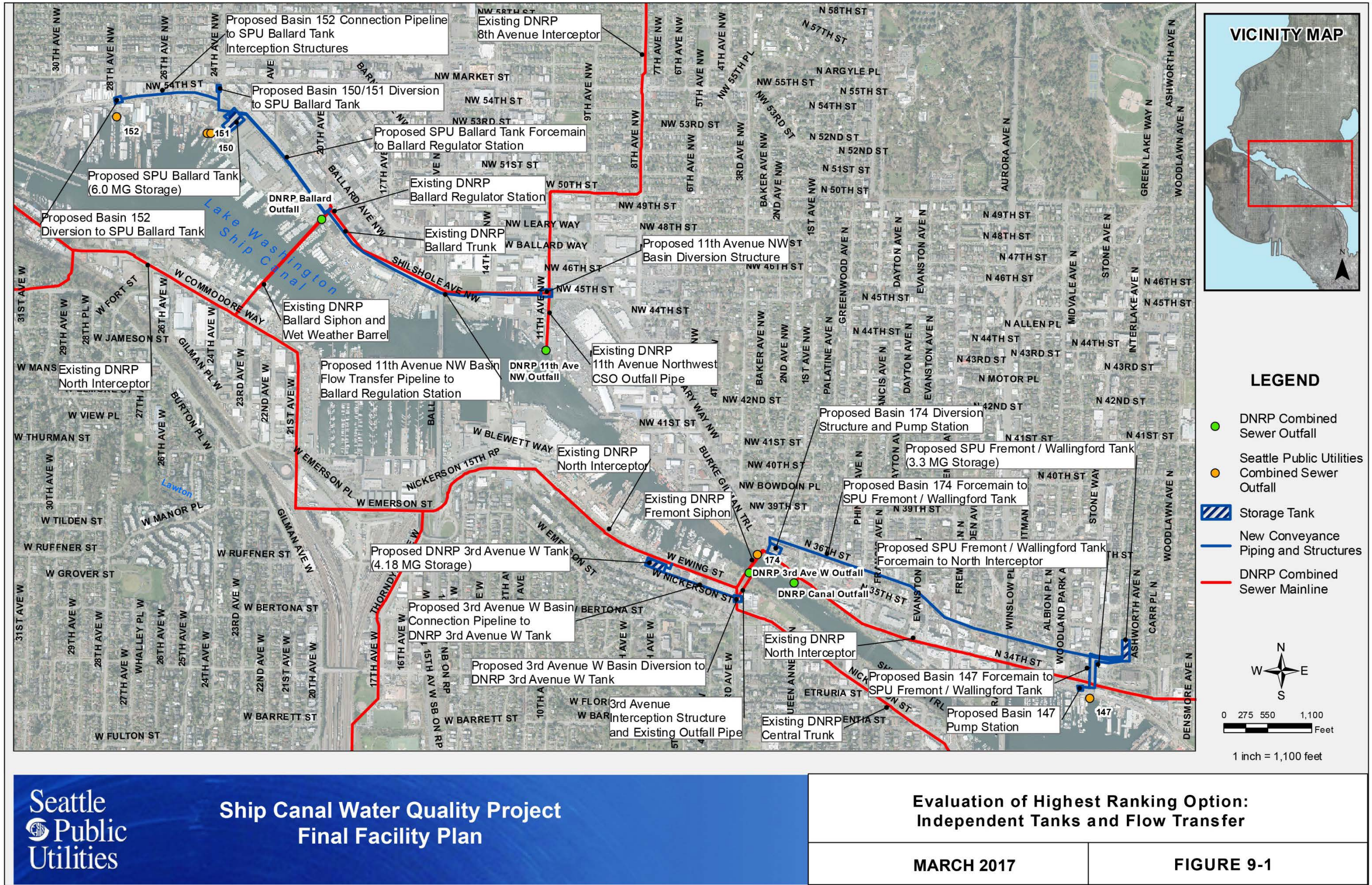
Evaluation Criteria	Independent Tanks/Flow Transfer	Shared Tunnel
1. Technical complexity and Performance Risk	Four independent systems would be required that increase overall complexity and performance risk.	Lower overall system operational complexity because of a large number of independent CSO outfall storage have been combined into a single CSO control facility
2. Flexibility	Independent storage facilities would provide less flexibility than storage tunnels.	More operational flexibility for both King County and SPU given its aggregate volume and location More adaptable for changing control criteria and flow conditions
3. Constructability	There would be more complicated permitting and regulatory compliance due to dispersed, larger surface footprint. Four independent facilities at different locations throughout the City increases overall risks.	Less complicated permitting—one project vs. four. Siting has been completed for most of the project, and construction risks are better defined than for the independent projects.
4. Consent decree Compliance Schedule	There would be no need to revise King County LTCP projects or Consent Decree deadline for 3rd Avenue W.	Shared tunnel meets King County's Consent Decree following 2016 Non-Material Modification.
5. King County Concurrence on Shared Projects	Not applicable	This was a concern at the time the options were under evaluation, however both agencies have now entered into a JPA for the Shared Tunnel project.
6. Construction impacts (short-term)	Independent tanks and flow transfer would have more truck trips, potentially more contaminated soil, more permanent superficial impacts, and require more land.	Shared tunnel would be more amenable to alternative transportation (e.g., rail, barge), with high local construction impact but lower overall impact to the project area.

Table 9-4. Nonmonetized Evaluation of Options 1 and 3

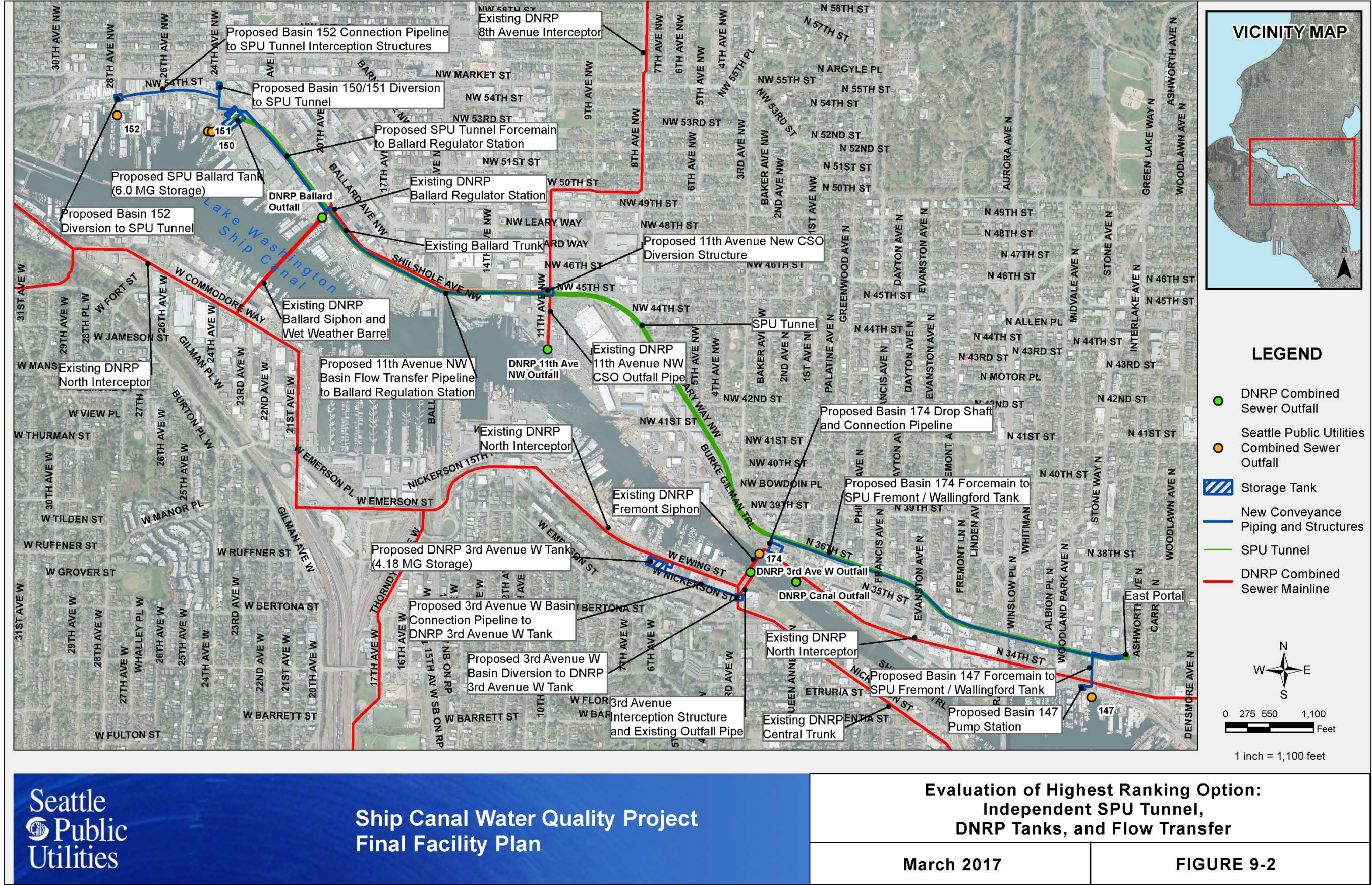
Evaluation Criteria	Independent Tanks/Flow Transfer	Shared Tunnel
7. Community impacts (long-term)	More permanent surficial impacts would result, more land would be affected, and more ongoing maintenance would be required in more communities.	Post construction, a significant portion of tunnel property could be sold or put to another public use.
8. Environmental/ Social Justice	Disproportionate impacts to minority or low income populations would not be not expected.	Disproportionate impacts to minority or low income populations would not be not expected.
9. Environmental	Shallow contaminated soils would be more likely to be encountered and disturbed, and shallow unanticipated obstructions would be more likely to be encountered.	Because there would be sites, project would less likely encounter and disturb shallow contaminated soils and encounter shallow unanticipated obstructions.
10. Ease of O&M and safety	More independent systems would have to be maintained.	There would be minimal mechanical and instrumentation components and reliable in intermittent use.

Table 9-4 summarizes the social and environmental costs, benefits, and risks that were considered and is the basis of the recommendation of Option 3, Shared SPU and DNRP Tunnel. Option 3 does well in maximizing the flexibility of future expansion of the tunnel. Compared with independent tank-based storage and flow transfer, Option 3 minimizes community disruption from construction, number of significant construction sites required, length of conveyance required for other non-tunnel options, and cost-risk and, therefore, was the clear highest-ranking option. Chapter 10 provides a detailed discussion of the Recommended Option for the Ship Canal WQ Project.

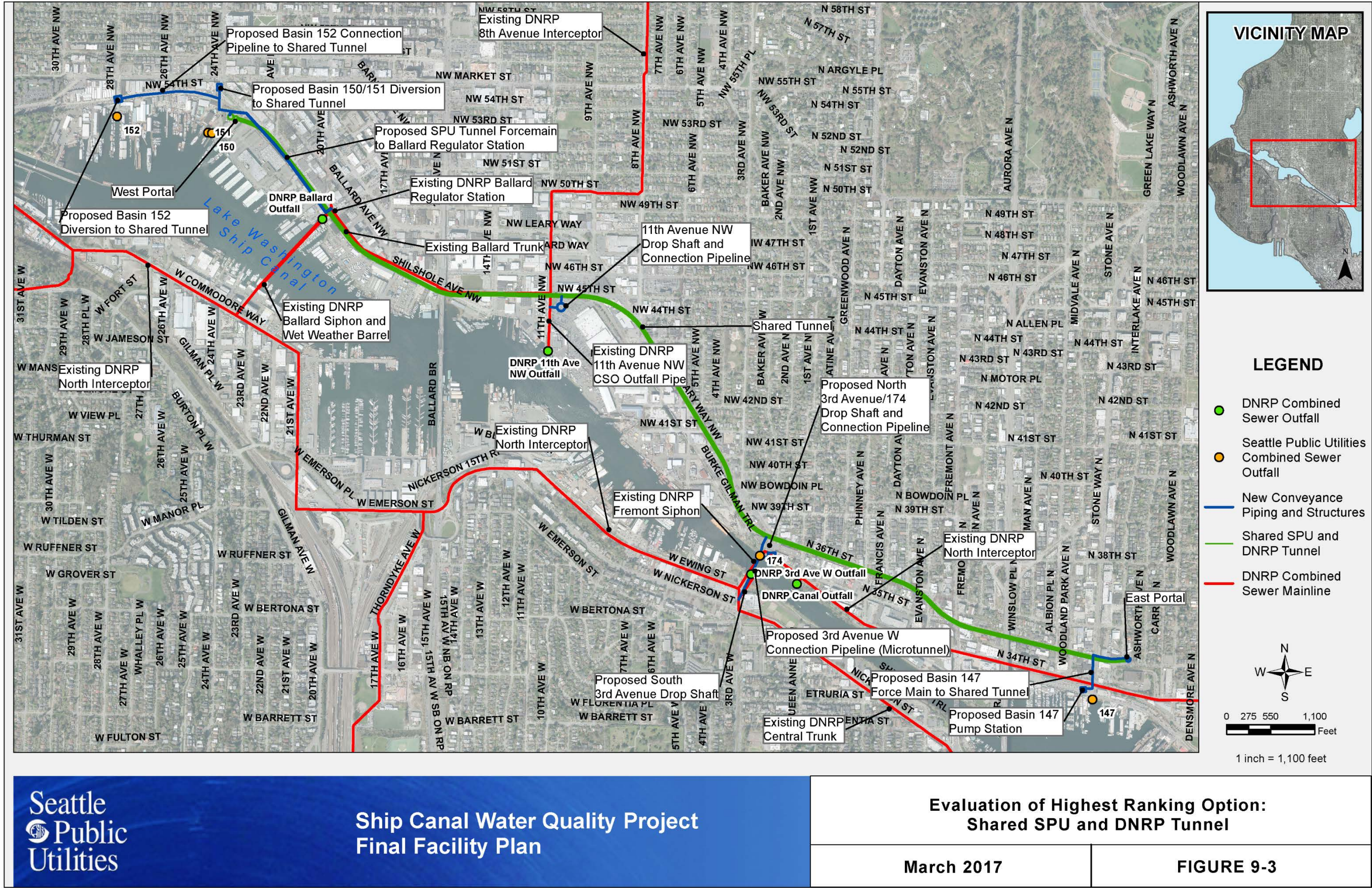
This page intentionally left blank



This page intentionally left blank



This page intentionally left blank



This page intentionally left blank

10 Recommended Option

This chapter provides additional engineering and environmental information for the Ship Canal WQ Project recommended option. Chapter 9 provides some information regarding the recommended option. This chapter fully describes the recommended option and presents O&M requirements developed after the recommended option was selected by SPU and DNRP. The detailed configuration presented in this chapter will be subject to additions, modifications, or deletions of described facilities during final design as project understanding and performance requirements are refined and additional data are collected.

10.1 Overview

The Ship Canal WQ Project will provide offline storage of combined wastewater in a deep storage tunnel constructed between the Ballard and Wallingford CSO areas, on the north side of the Ship Canal. The project will control SPU's Ballard CSO basins (Outfalls 150, 151, and 152), SPU's Fremont CSO basin (Outfall 174), SPU's Wallingford CSO basin (Outfall 147), DNRP's 3rd Avenue W Overflow Structure (DSN008), and DNRP's 11th Avenue NW Overflow Structure (DSN004). Figure 1-1 in Chapter 1 provides a general project area overview and general Ship Canal WQ Project configuration. Figures 10-1 and 10-2 provide a more detailed plan view of the Ship Canal WQ Project facilities location and main system components.

The main components of the Ship Canal WQ Project include the storage tunnel and appurtenances, flow diversion and conveyance facilities to divert and convey SPU and DNRP CSO flows into the tunnel, and a pump station and effluent conveyance to drain the tunnel back into the wastewater system for secondary treatment at West Point Treatment Plant. The shared storage tunnel and appurtenances identified during conceptual planning will include the following:

- A minimum 15.24-MG offline storage tunnel with a nominal 14-foot to 18-foot ID and approximately 14,000 feet long. The final tunnel ID, depth, and length will be based on site-specific information collected during the project design phase:
 - The stored combined sewage in the storage tunnel will flow from the East Portal in Wallingford westward to the TEPS in Ballard
 - The tunnel alignment is planned to be primarily in street right-of-way along the north side of the Ship Canal.
- Seven diversion structures for diverting combined sewage away from existing CSO outfalls to the tunnel.

- Five drop structures will convey combined sewage from the surface into the storage tunnel; four structures will have an odor control system. Additional odor control facilities will be evaluated during final design.
- A pump station (TEPS facility) located at the West Portal with an average capacity of 32 MGD to empty the storage tunnel in approximately 12 hours based on current design criteria.

Conveyance facilities will include the following:

- Gravity sewer line to convey flows from SPU's diversion structure at Ballard Outfalls 151 (approximately 440 linear feet of 36- to 48-inch diameter pipe) and 152 (approximately 2,200 linear feet of 60-inch-diameter pipe) to the tunnel drop shaft.
- Gravity sewer line to convey flows from SPU's diversion structure at Fremont Outfall 174 to the tunnel drop shaft (approximately 120 linear feet of 36-inch to 48-inch-diameter pipe).
- Gravity sewer line to convey flows from DNRP's diversion structure at 3rd Avenue W (under the Ship Canal) to the tunnel drop shaft (approximately 740 linear feet of 18-inch to 60-inch-diameter pipe).
- Gravity sewer line to convey flows from DNRP's diversion structure at 11th Avenue NW to the tunnel drop shaft (approximately 120 linear feet of 60-inch to 72-inch-diameter pipe).
- Gravity sewer line to convey flows from SPU's diversion structure at Wallingford Outfall 147 to the tunnel drop shaft (approximately 1,000 linear feet of 24-inch to 30-inch-diameter pipe).
- Effluent discharge piping convey flows from the tunnel pump station to SPU's local sewer (approximately 100 linear feet of 24-inch-diameter pipe) and DNRP's existing Ballard Siphon wet-weather barrel forebay (approximately 1,900 linear feet of 36-inch to 72-inch-diameter pipe).

All conveyance sizing and quantities, including the storage tunnel, are approximate estimates based on current design to date. Actual diameters, lengths, and alignments of conveyance facilities will be determined during final design phase.

Gravity sewer lines to convey flows from SPU's diversion structures at Ballard Outfalls 151 and 152 and Wallingford Outfall 147 to the tunnel drop shafts have been excluded from the cost share in accordance with the Joint King County/Seattle CSO Initiative Work Plan Item 4: Cost-Sharing Method for Joint Capital Projects (SPU and King County, 2012). These conveyance lines are the sole responsibility of SPU.

Control strategies for system operation will be refined during final design. Following are the minimum control volumes:

- SPU Basins:
 - Fremont (Basin 174): 1.06 MG
 - Wallingford (Basin 147): 2.15 MG
 - Ballard (Basin 152): 5.38 MG
 - Ballard (Basin 150/151): 0.62 MG
- DNRP Basin:
 - 3rd Avenue W (DSN008): 4.18 MG
 - 11th Avenue NW (DSN004): 1.85 MG

Each agency has calculated the control volumes required to meet their independent needs. Although calculation methods vary between the agencies, SPU and DNRP agree that these are the minimum control volumes to be provided by the Ship Canal WQ Project.

Following are key system components of the recommended option:

- **Storage Tunnel**—The baseline storage tunnel is 14-foot nominal diameter with a minimum of 15.24-MG storage capacity; the actual diameter will be determined during project design. To determine a project envelope of construction and environmental impacts and costs, the tunnel turning radii and construction shaft sizing will be based on a maximum 18-foot-diameter tunnel. The tunnel will have a depth of 50 to 100 feet for most of its alignment, depending on the alignment revisions during the project final design. Flows will enter the storage tunnel by gravity and be pumped to the local SPU sewer and DNRP regional interceptor when downstream capacity in these systems is available. A flushing system at the East Portal will be used to clean the storage tunnel following operation to remove accumulated solids and debris.
- **TEPS**—A 32-MGD pump station will be constructed at the West Portal, located within and above the deep shaft used to construct the tunnel to access the tunnel effluent for pumping. An above-grade building will provide secured access to the pump station dry-well and wet-well areas. An on-site diesel-powered generator will provide standby power. The TEPS will be designed for automated operation (unstaffed) and include safety and ventilation systems; electrical and control systems; access considerations and spatial considerations for on-site maintenance; permanent lifting equipment; and other operational systems required for safe long-term O&M activities.
- **Drop Shafts, Portals, and Vortex Drop Structures**—Drop shafts and portals will be finished facilities located along the tunnel alignment providing conveyance functions and tunnel access. Located within the West Portal (wet well), 11th Avenue NW Drop

Shaft, North 3rd Avenue/174 Drop Shaft, South 3rd Avenue Drop Shaft, and East Portal, vortex drop pipes will convey overflows vertically downward from near-surface conveyance pipelines to the storage tunnel and allow movement of air to the odor control facilities. The drop shafts and portals will also provide access to the tunnel along the alignment for entry into the tunnel by SPU staff as appropriate. Standby diesel-powered generators located at the portals and most drop shafts will provide sufficient backup power to control systems communications equipment, instrumentation, and nearby control gates located at conveyance system diversion structures.

- **Conveyance**—This project will include structures needed to intercept combined sewer flows during storm events from the SPU and DNRP CSO basins. Gravity pipelines will convey flows to the storage tunnel. Diversion structures with control gates will direct water either into the tunnel or to existing outfalls. Conveyance elements will also include the TEPS effluent discharge pipeline that will convey pumped flows to the Ballard Regulator Station and a new grit removal structure in SPU's Basin 152 upstream of the CSO interception structures. The primary anticipated construction method for conveyance pipes will be open-cut construction. Some sections will be constructed using microtunneling (trenchless method) to avoid extended surface impacts; cross under critical utilities, railroads, and streets; and construct the 3rd Avenue W CSO connection under the Ship Canal to the North 3rd Avenue/174 Drop Shaft. Real-time controls, including automated adjustable gates, and level and flow sensors will be included at diversion structures and actively control flows entering the storage tunnel and determine flows diverted to the existing outfalls.
- **Odor Control**—An odor control system incorporating a fan and activated carbon-scrubbing media to treat foul air from the tunnel will be located at the TEPS. An underground electrical and mechanical vault containing activated-carbon odor control system, mechanical, electrical, and control systems will be located at the 11th Avenue and North 3rd Avenue/174 Drop Shafts and the East Portal. Odor control will be provided to South 3rd Avenue from the North 3rd Avenue/174 odor control system. Odor control at other locations will be evaluated during final design.
- **Modifications to Existing System**—Existing structures may be modified based on the results of hydraulic modeling completed during final design.

In addition to the key project components described above, the project will incorporate the following elements:

- **24th Avenue NW Pedestrian Pier Improvements**—A considerable portion of tunnel construction spoils and other waste materials will be transported to a disposal site using barges. The existing 24th Avenue NW Pedestrian Pier located adjacent to the West Portal will require reconstruction in its current location to accept the anticipated

loading equipment required for the effective use of barges. When the project is completed, the reconstructed pier will be converted back to a public amenity.

- **Outfall 151 Rehabilitation**— The existing 18-inch-diameter wood-stave Outfall 151 is in poor condition, and rehabilitating it during Ship Canal Project construction would be less disruptive to the community than rehabilitating it in a separate construction project. SPU plans to replace both the existing Outfall 151 and the existing 30-inch-diameter HDPE Outfall 150 with a single HDPE 48-inch-diameter outfall. This replacement Outfall 151 will be installed under the new 24th Avenue NW Pedestrian Pier.

10.2 Layout

10.2.1 Proposed Facilities

The detailed configuration of proposed facilities presented in this section will be subject to additions, modifications, or deletions during final design as project understanding and performance requirements are refined and additional data is collected.

10.2.1.1 Storage Tunnel

The new storage tunnel alignment starts at the upstream East Portal located on City-owned property at the northeast corner of N 35th Street and Interlake Avenue N. The alignment follows N 35th Street west in the right-of-way to Fremont Avenue N and continues along Fremont Place N and N 36th Street. Near the intersection of Leary Way NW and N 36th Street, the alignment connects to the North 3rd Avenue/174 Drop Shaft (in the right-of-way) and completes a turn northwards along Leary Way NW. The alignment continues northwards along Leary Way NW to NW 45th Street and completes a turn westward on NW 45th Street. Near 11th Avenue NW, the tunnel connects to the 11th Avenue Drop Shaft and continues west in the right-of-way along NW 45th Street. Near 15th Avenue NW, the alignment shifts northwest and follows Shilshole Avenue NW in the right-of-way until reaching the West Portal located on City-owned property at the southeastern corner of Shilshole Avenue NW and 24th Avenue NW.

The tunnel alignment includes a “tunnel easement envelope” that provides a horizontal and vertical offset to protect the tunnel from future surface and subsurface development. This envelope generally extends 20 feet from the top/bottom, and 10 feet from the lateral sides of the tunnel. Permanent easements for the tunnel envelope will be negotiated with private property owners where the envelope limits fall outside of public right-of-way.

The alignment generally follows paved arterial or secondary streets and attempts to avoid residential street right-of-ways. These routing criteria were developed to reduce

impacts to private property from a tunnel machine intervention should this be required during construction.

10.2.1.2 *West Portal Site*

The West Portal site is located on 2.15 acres of City-owned property at the southeastern corner of Shilshole Avenue NW and 24th Avenue NW. This site is bound to the north by a rail spur line (operated by the Ballard Rail Road Company), to the west by 24th Avenue NW, to the south by Salmon Bay, and to the east by an adjacent private parcel containing parking lots and commercial/industrial buildings. The West Portal site consists primarily of paved parking with some vegetated planting strips and buffers. A former restaurant is located at the southern end at the Salmon Bay waters edge. The 24th Avenue NW Pedestrian Pier is located at the site's southwest corner. The site is generally graded flat with some grade changes supported by retaining walls and rockery walls. Primary tunnel construction activities and the permanent TEPS location will be at the West Portal site.

10.2.1.3 *11th Avenue Drop Shaft Site*

The 11th Avenue Drop Shaft site is located in the public right-of-way along NW 45th Street between 11th Avenue NW and 9th Avenue NW. The proposed site layout is shown on Figures 10-13 and 10-14. A portion of the site currently extends onto private property to the south. This area is needed to construct the tunnel drop shaft and subterranean access corridor. A buried electrical and mechanical vault will be located adjacent to the drop shaft structure in the right-of-way. A new diversion structure (downstream of the existing overflow structure) to convey flows to the tunnel or outfall will be constructed in the right-of-way on DNRP's 11th Avenue NW outfall pipeline near the intersection of 11th Avenue NW and NW 45th Street.

10.2.1.4 *North 3rd Avenue/174 Drop Shaft Site*

The North 3rd Avenue/174 Drop Shaft site is located in the public right-of-way along NW 36th Street between 3rd Avenue NW and Leary Way NW. The proposed site layout is shown on Figures 10-17 and 10-18. A portion of the site currently extends onto King County-owned and SDOT properties to the south. The King County-owned parcel is the location of the forebay for the new Fremont Siphon crossing for the North Interceptor. This area is needed for constructing the tunnel drop shaft and housing a permanent buried electrical and mechanical vault. SPU will work with DNRP to ensure existing facilities will not be impacted by the construction and to obtain necessary temporary and permanent easements.

10.2.1.5 *South 3rd Avenue Drop Shaft Site*

The South 3rd Avenue Drop Shaft site is located at the West Ewing Park parking lot east of the terminus of 3rd Avenue W at the Ship Canal in the right-of-way. The paved

parking lot is generally graded flat and is currently owned by the City. The proposed site layout is shown on Figure 10-21. This area will be used to construct the permanent drop shaft connection that will convey flows from the 3rd Avenue W diversion to a new pipe (microtunnel) under the Ship Canal. This microtunnel will connect to the North 3rd Avenue/174 Drop Shaft. A new outfall diversion structure will be constructed on DNRP's 3rd Avenue W outfall pipeline near the intersection of 3rd Avenue W and W Ewing Street, south of the Ship Canal Trail.

10.2.1.6 East Portal Site

The East Portal site is located at 3500 Interlake Avenue N. This property is owned by the City (Finance and Administrative Services [FAS]). The proposed site layout is shown on Figure 10-24. All permanent structures associated with the tunnel East portal, including a small above-grade electrical building, will be located on the site. The site generally slopes downward to the south, with retaining walls supporting the eastern and northern boundaries. A building on this site was recently demolished and the site has been converted to a parking lot. An agreement is being finalized to lease the site during construction and purchase the required property for the completed facility. Excess property would be retained under FAS ownership.

10.2.2 Revisions to Existing Facilities and Site Access

SPU will close some existing facilities and site access to the public throughout the construction duration. At the West Portal site, access to the 24th Avenue NW Pedestrian Pier will be closed during project construction as the pier is rehabilitated and used for loading tunnel excavation spoils onto barges with conveyors. The parking lot near the South 3rd Avenue Drop Shaft will be closed during construction for work and contractor staging.

Portions of the existing Burke-Gilman Trail will be temporarily closed and rerouted around the North 3rd Avenue/174 Drop Shaft and 11th Avenue Drop Shaft sites when constructing the deep tunnel shafts and connecting conveyance pipelines to the drop structures. Temporary lane closures will also be required as part of constructing the North 3rd Avenue/174 Drop Shaft site.

Access to the new CSO facilities by maintenance vehicles will be from the right-of-way onto City- or King County-owned properties or directly in the right-of-way. Dedicated parking spaces will be provided on City or King County-owned properties at the West Portal, 11th Avenue Drop Shaft, North 3rd Avenue/174 Drop Shaft, and East Portal. Parking spaces at the North 3rd Avenue/174 Drop Shaft will be marked with parking hour restriction signage marked for Class C (SPU and Seattle Department of Parks and Recreation) vehicles.

Measures to prohibit entry to the construction area without proper authority will include a temporary fence. Replanting of existing surface areas disturbed by construction activities and not covered by new features or pavement will consist of native plantings, shrubs, and trees in accordance with the Seattle Department of Parks and Recreation recommendations for site improvements to the Burke-Gilman Trail or SDOT recommendations for right-of-way improvements. Replanting activities on sites owned by the City or King County will be designed by SPU's landscaping consultant during final design.

Constructing conveyance pipelines will temporarily restrict access to some driveways and parking. SPU will work with DNRP to determine the feasibility of using DNRP-owned properties for parking during construction. If determined feasible, SPU will obtain the required temporary construction easements.

10.2.3 Access to Proposed Facilities

Access to the tunnel portals and electrical and mechanical vaults will be via hatches (rated for HS-25 loading) at the ground surface. Other areas of these structures will contain removable lifting slabs for less frequent maintenance activities. These facilities and access points will be generally located outside of vehicular travel lanes.

10.2.4 Street Frontage Right-of-Way Improvements

Street frontage right-of-way improvements are not anticipated for this project and will be confirmed based on the requirements of the SDOT and Seattle Department of Construction and Inspections.

10.2.5 Stormwater

The Ship Canal WQ Project consists of improvements that also are classified as "parcel based" with stormwater requirements, described in Seattle Municipal Code 22.805.050. The West Portal site is in a separated storm drain area, discharging storm flows from the site to Salmon Bay. This option proposes to construct the new TEPS facility with approximately 43,580 square feet of replaced impervious surface (most of which is considered pollution generating). A total of 63,000 square feet of impervious surface currently exists at the site. This option will remove approximately 19,650 square feet of impervious surface and replace with landscaping and planting areas. Therefore, according to the 2016 Director's Rules for the City's Stormwater Code (Seattle Municipal Code Chapters 22.800-22.808), runoff from the site triggers water quality treatment and onsite stormwater management. To estimate treatment requirements, pollution-generating impervious surfaces include driveway and parking lots, while non-pollution-generating surfaces include concrete sidewalks.

This option also will implement onsite stormwater management (Seattle Municipal Code 22.805.020.F), which may include runoff reduction methods of permeable pavement and amended soils. The project will incorporate bioretention planters at the West Portal site for water quality treatment. Other sites and replaced right-of-way pavement may treat stormwater runoff using a Filterra™ system or other similar technology.

Design elements to treat and convey stormwater will be revised as appropriate as the project design and construction management strategy is developed in the future. Runoff generated from right-of-way surfaces may also qualify for an exemption from these standards since the entire project is to improve overall water quality.

10.2.6 Landscaping

Existing landscaping at the different project sites and along the near-surface conveyance alignments will be removed to limits required to complete construction. Most landscaping in the public right-of-way along the deep storage tunnel alignment (outside of indicated drop shaft sites) will not be directly impacted as part of the tunnel construction because the tunnel will be constructed using a subsurface tunnel boring machine. However, landscaping removal (primarily tree pruning or limbing) may be limited during construction to install and periodically monitor settlement monitoring equipment. The project will strive to preserve outstanding trees.

Project site landscaping will vary by location. The West Portal and East Portal sites will be landscaped using a mix of native plants and preferred decorative species. This project aspect will be finalized during final design. The 11th Avenue and North 3rd Avenue/174 Drop Shaft sites are primarily in the right-of-way. Landscaping will be as prescribed by current SDOT street planting requirements. Similarly, landscaping along conveyance alignments will be as prescribed by current SDOT street planting requirements.

10.2.7 Hydraulic Profiles

Existing and proposed structures and conveyance pipelines are shown with hydraulic profiles for the peak-flow operating conditions anticipated for the recommended option on Figures 10-3 through 10-9. These profiles schematically represent the interconnections of the proposed project components and connections to the existing SPU and DNRP wastewater conveyance systems. Hydraulic profiles may change based on overall system refinements made during final design.

10.3 Storage Tunnel

A minimum 15.24-MG offline storage tunnel will be located under primarily public right-of-way north of the Ship Canal. The nominal 14-foot finished inner diameter storage

tunnel will extend from Wallingford to Ballard, and will be approximately 14,000 feet long. The storage tunnel will store excess combined sewer flows from SPU Basins 147, 150/151, 152, and 174. The storage tunnel will also store excess combined sewer flows from DNRP Basins 3rd Avenue W (DSN008) and 11th Avenue NW (DSN004).

During storm events, flows from any of the six basins will be piped to the storage tunnel via dedicated conveyance pipes from diversion structures and enter the storage tunnel via drop shafts and portals located at each end of the tunnel and at two locations along the alignment. Flows entering the storage tunnel will be stopped by motor actuated gates at each diversion once a pre-determined set point has been reached based on flow contribution (gallons) from each basin, or a pre-determined level in the storage tunnel has been reached. Once a gate has closed, excess flows will be routed to that CSO basin's associated outfall. The system will be provided with motor-actuated gates, and controls will be provided to allow flexibility to effectively control the system to meet performance standards.

A self-cleaning system using a control gate located at the eastern-most upstream end (East Portal) will provide a flushing wave (approximately 80,000 gallons of stored sewage) to move settled materials from the storage tunnel to the downstream western-most end (West Portal). Modeling analysis was used to confirm the volume required for the flushing wave to achieve a minimum velocity of 3 feet per second along the entire tunnel alignment. This velocity value was selected based on the typical grain-size distribution of sediment typically found in domestic combined sewer systems and the ability of a flushing wave at that velocity to resuspend materials and convey them to the terminal end of the tunnel. A pump station at the West Portal (TEPS) will pump the materials and flushing water to the Ballard Regulator Station near the ground surface. The Ballard Regulator Station discharges to the DNRP system and flow is conveyed to the West Point Wastewater Treatment Plant for treatment.

The storage tunnel will be kept under a slight (approximate 0.1-inch water column) negative air pressure by continuously drawing air from the storage tunnel headspace and treating it with an odor control system at the West Portal. Odor control is included at each of the other three portals to treat foul air during tunnel filling.

The tunnel has 14-foot minimum finished inner diameter. For the basis of determining a project envelope of construction and environmental impacts and costs, the tunnel turning radii and construction shaft sizing is based on an 18-foot finished inner diameter tunnel. The storage tunnel minimum inside finished diameter required to store the project control volume is 14 feet. A 14-foot inner diameter tunnel has a smaller (tighter) turning radius than the 18-foot tunnel, and could be constructed in the same alignment.

Access to the storage tunnel will be through the tunnel portals and drop shaft structures. The design includes ladders and platforms for inspection and maintenance activities. Access to the ladders will be through surface hatches or buried corridors leading to the portal or drop shaft. Removable concrete panels at the portals can be lifted by crane to facilitate placing equipment into the storage tunnel, such as a small skid steer or other machinery used for cleaning or repairs.

10.4 Tunnel Access Locations

Portals and drop shafts are finished facilities located along the tunnel alignment that provide conveyance functions and tunnel access. Access locations are located at the West Portal (wet well of the TEPS), 11th Avenue Drop Shaft, North 3rd Avenue/174 Drop Shaft and East Portal sites. Portals and drop shafts range in depth from approximately 60 feet to 100 feet (to bottom of tremie slab), and an inner diameter from 10 feet to 50 feet. Drop structures within the access structures convey flows vertically downward from near-surface conveyance pipelines to the storage tunnel below. The access locations provide entrance into the tunnel along the alignment for entry by SPU staff as needed to perform maintenance. Standby diesel-powered generators situated above ground are located at each portal to provide backup power to instrumentation and nearby control gates located at conveyance system diversion structures.

A fifth deep shaft structure, the South 3rd Avenue Drop Shaft, will be located south of the Ship Canal in the West Ewing Mini Park parking lot east of 3rd Avenue W and W Ewing Street to convey flows from the 3rd Avenue W outfall to a new microtunnel connection to the North 3rd Avenue/174 Drop Shaft. The South 3rd Avenue Drop Shaft will have a 20-foot inner diameter and will be approximately 80 feet deep.

10.4.1 West Portal

The West Portal is adjacent and connected to the TEPS facility, and serves as the TEPS wet well and a point of access to the tunnel. Refer to Section 10.5 for additional detail of the West Portal configuration. Figure 10-10 shows the proposed site plan of the West Portal and TEPS site. Figures 10-11 and 10-12 show three-dimensional views of the proposed finished TEPS facility, constructed inside of the West Portal structure that will be used for tunnel construction before being reconfigured as the final TEPS facility.

10.4.2 11th Avenue Drop Shaft

The 11th Avenue Drop Shaft site is located in the public right-of-way along NW 45th Street between 11th Avenue NW and 9th Avenue NW. Figures 10-13 and 10-14 show the proposed site plan of the 11th Avenue NW Drop Shaft. Figures 10-15 and 10-16 show three-dimensional views of the proposed structure. The finished drop shaft will send flows to the tunnel through an adit, which is a short tunneled connection to the

main tunnel. A second small shaft drilled directly over the tunnel will provide ventilation and odor control. Primary access to the mechanical/ electrical vault is via a surface hatch in the planting strip/sidewalk south of the drop shaft in the right-of-way. This access hatch provides access to the buried facilities without requiring SPU crews to temporarily close NW 45th Street. A vault containing metering equipment may be placed in-line with the conveyance past the diversion and before the drop structure.

The electrical and mechanical vault at this site is located east of the drop shaft in the right-of-way. The standby diesel-powered generator is located above grade in close proximity to the electrical and mechanical vault. Buried odor ductwork from the electrical and mechanical vault connects to the smaller secondary drop shaft east of the primary drop shaft.

The 11th Avenue NW connection pipeline will enter the drop shaft from the west and connect to an approximately 60-foot deep drop pipe to vertically convey flows to the storage tunnel. The drop pipe will discharge to a concrete stilling well offline from the main tunnel alignment in the bottom of the drop shaft before entering the tunnel through the adit.

10.4.3 North 3rd Avenue/174 Drop Shaft

The North 3rd Avenue/174 Drop Shaft is located in the public right-of-way along NW 36th Street between 3rd Avenue NW Leary Way NW. Figures 10-17 and 10-18 show the proposed site plan for the North 3rd Avenue/174 Drop Shaft. Figures 10-19 and 10-20 show three-dimensional views of the proposed structure. The finished drop shaft will be directly accessible from the surface through hatches, lift slabs, and maintenance hole openings in the structure lid located in the NW 36th Street right-of-way. Primary access to the drop shaft will be through hatches in the right-of-way, requiring SPU crews to temporarily close NW 36th Street for inspection and maintenance. A caged ladder assembly extends from the access hatches to the bottom of the drop shaft.

The odor control system at this site will be located in the electrical and mechanical vault, near the new Fremont Siphon and in SDOT right-of-way. The standby diesel-powered generator is located above grade in close proximity to the electrical and mechanical vault on SDOT property. Buried odor ductwork from the electrical and mechanical vault connects to the upper part of the drop shaft. SPU will work with DNRP to ensure no conflicts occur to existing King County facilities and will obtain required necessary temporary and permanent easements.

The Outfall 174 connection pipeline enters the portal structure from the east and connects to a drop pipe that vertically conveys flows to the storage tunnel. The drop pipe will be up to 30 inches in diameter and affixed to the portal wall. A vault containing metering equipment may be placed in-line with the conveyance past the diversion and

before the drop structure. The drop pipe will discharge to a concrete stilling well offline from the main tunnel alignment in the bottom of the portal.

The 3rd Avenue W microtunnel connection pipeline enters the North 3rd Avenue/174 Drop Shaft from the southeast and directly discharges to the same concrete stilling well that accepts flows from the CSO 174 drop pipe. Flows will cascade into the tunnel opening via an adit, which is a short tunneled connection to the main tunnel.

10.4.4 South 3rd Avenue Drop Shaft

The South 3rd Avenue Drop Shaft site is located at a parking lot east of the terminus of 3rd Avenue W at the Ship Canal in the right-of-way. Figure 10-21 shows the proposed site plan for the South 3rd Avenue Drop Shaft. Figures 10-22 and 10-23 show three-dimensional views of the proposed structure. The finished drop shaft will be directly accessible from the surface through hatches, lift slabs, and maintenance hole openings in the structure lid located in the parking lot. Primary access to the structure will be through hatches in the parking lot, requiring SPU crews to temporarily restrict use of the parking lot for inspection and maintenance.

The 3rd Avenue W connection pipeline will enter the drop shaft structure from the south. The drop pipe will be up to 60-inch inner diameter and affixed to the drop shaft wall. The drop pipe discharges to a bottom of the shaft and flows enter two gravity conveyance pipes (42-inch and 18-inch), sized for different flows and constructed inside of a 72-inch to 96-inch-diameter microtunnel that conveys flows under the Ship Canal to the North 3rd Avenue/174 Drop Shaft.

Odor control and standby power will be provided by the North 3rd Avenue/174 facility north of the Ship Canal. Odor control will be performed with an air jumper pipe, and back-up power will be provided by conduits, both located within the microtunnel.

10.4.5 East Portal

The East Portal site is located at 3500 Interlake Avenue N. Figure 10-24 shows the proposed site plan for the East Portal. Figures 10-25 and 10-26 show three-dimensional views for the proposed structure. The finished portal will be directly accessible from the surface through hatches, lift slabs, and maintenance hole openings in the structure lid located in the City property. Primary access to the structure will be through hatches in the driveway of the finished site.

The odor control facility at this site is located in a vault attached to the portal shaft. The standby diesel-powered generator is located above ground on the south side of the portal on the City property. A small above-grade electrical building will also be located near the portal shaft.

The Outfall 147 connection pipeline enters the portal structure from the south and connects to a drop pipe that vertically conveys flows to the storage tunnel. The drop pipe will be up to 30 inches in diameter and affixed to the portal wall. The drop pipe will be held in place by supports anchored to the wall and concrete encased to protect the pipe material from corrosion and damage from maintenance activities and provide additional structural support. The drop pipe will discharge to a concrete stilling well offline from the main tunnel alignment in the bottom of the portal. This stilling well will also serve to temporarily hold back flow for release by a control gate. When the control gate releases a flushing wave, the stored CSO will flow into the tunnel to remove sediment and carry it to the TEPS wet well.

10.5 Tunnel Effluent Pump Station

A 32-MGD pump station will be constructed at the West Portal. The primary purpose of the TEPS is to dewater the storage tunnel in approximately 12 hours once capacity is available in the conveyance system. The proposed primary tunnel dewatering pumping system will use two duty pumps. The final configuration and number of duty and standby primary tunnel dewatering pumps will be evaluated during final design and will meet design and regulatory requirements. The primary tunnel dewatering pumps are designed for raw sewage service, dry-pit submersible-type pumps and are identical in size. The rated capacity for each pump at the design condition is 16 MGD at 60 feet total dynamic head. Primary tunnel dewatering pumps will be equipped with variable speed drives to pump a range of flows based on the downstream sewer capacity at the DNRP North Interceptor.

Initial tunnel dewatering will start with secondary wet-well dewatering pumps. Two of the secondary wet-well dewatering pumps will operate one hour before starting the primary tunnel dewatering pumps to remove the majority of settled material in the wet well. The primary tunnel dewatering pumps will start to drain the tunnel and continue pumping until the level in the wet well is below a shut-off point. The wet-well dewatering pumps will stay in operation during tunnel dewatering, continuing to remove settleable materials. Once the tunnel is emptied to the level where the primary pumps shut off, the secondary wet-well dewatering pumps will continue to drain the wet well. The secondary wet-well dewatering pumps will also drain the wet well following tunnel self-cleaning with the flushing wave generated at the East Portal.

The TEPS facility will be located within and above the deep shaft used to construct the tunnel. An above-grade building will provide secured access to the pump station dry-well and wet-well areas. The proposed TEPS site plan and sections are shown on Figures 10-10 and 10-11.

Odor control at the TEPS will be located in the TEPS building. Odors will be mitigated using activated carbon media housed in the odor control vessel to scrub odor-causing compounds from air drawn from the tunnel and wet well. Corrosion-resistant ductwork connecting the odor control structure to the TEPS wet well will be buried underground. The odor control fan will be located inside of the TEPS building to provide better noise mitigation from continuous fan operations. Scrubbed air will discharge from the odor control fan through an exhaust stack through the roof of the TEPS building.

An on-site diesel-powered generator will provide standby power for up to 48 hours of continuous operation for the pump station equipment during power outages and will be housed in a sound-reducing cover system to minimize noise impacts. The TEPS will be designed for automated operation (unstaffed) and include safety and ventilation systems; electrical/control systems; access considerations, including stairways and an elevator; spatial considerations for on-site maintenance; permanent lifting equipment; and other operational systems required for safe long-term O&M activities.

The TEPS effluent discharge pipeline will consist of 36-inch to 72-inch-diameter pipe with a length of approximately 1,900 linear feet. The effluent discharge pipeline will begin at the north side of the TEPS and extend northeast to the north side of Shilshole Avenue NW. The proposed alignment generally follows Shilshole Avenue NW southeast to the Ballard Regulator Station, located on the corner of Shilshole Avenue NW and NW Dock Pl. The effluent discharge pipeline will be constructed using open cut and trenchless construction. Figure 10-4 shows the hydraulic profile of the TEPS effluent discharge pipeline under anticipated operating conditions.

The effluent discharge piping will connect to the Ballard Regulator Station at the existing siphon drop connection. Further design coordination with DNRP will be required for the connection at this location.

10.6 Auxiliary Portal and Drop Shaft Facilities

The 11th Avenue Drop Shaft, North 3rd Avenue/174 Drop Shaft and East Portal will have auxiliary structures and equipment required for O&M. An underground electrical and mechanical vault at these portal sites will contain an odor control system, mechanical equipment, electrical equipment, and control panels to modulate nearby control gates. The electrical and mechanical vaults will be constructed as separate structures nearby or adjacent to the portal structures. Access to the electrical and mechanical vaults will be through hatches and stairways to grade level. The exterior dimensions and configurations of the electrical and mechanical vault vary by site. The typical electrical and mechanical vault will be buried to minimize impact to the use of the sites and right-of-ways after construction. The design of the access hatches to the vault

will address utility conflicts and rerouting, maximize maintenance access, and minimize visual presence of the hatches at the surface.

The odor control system will consist primarily of a carbon adsorption scrubber vessel, grease filter, and exhaust duct. Provisions for a future fan and an in-line duct silencer include reserved space and connection points to the carbon vessel and ductwork. The system will allow foul air vented from the tunnel during filling to pass through the carbon media for treatment before discharge to the environment. The odor control system will connect to the portal structure with buried, corrosion-resistant ductwork or piping. Up to 200 feet of buried ductwork is anticipated for each of these facilities. Treated-air discharge ductwork will extend from the vault to exhaust plenums at the ground surface nearby.

Wash down water for cleaning the electrical and mechanical vault interior will be provided for maintenance. A small air gap tank (designed to meet WAC 246-290-490, Orange Book G2.2.2.3 G-1 and H-3 [Ecology, 2008], and Table 6.3 of Uniform Plumbing Code) and service pump system will be installed in the electrical and mechanical vault in the same space as the odor control system. Water service connections to the electrical and mechanical vaults from nearby water mains will be detailed during final design.

SPU provides on-site standby power for projects that are considered critical infrastructure and where significant consequences could occur if continuous power was lost (for example, a sewage pump station). The modulating gates and flow/level sensing instruments in diversion structures are critical to managing CSO event flows in the project area. Loss of power will prevent the gates from closing or opening during an event. However, this will not prevent the sewer collection system from continuing to operate. An on-site dedicated standby diesel-powered generator will be located above grade at the 11th Avenue, 3rd Avenue and East Portal sites since the storage tunnel will be used 40 to 60 times per year.

10.7 Basin 150/151 Conveyance

The proposed Basin 150/151 conveyance pipe alignment extends down 24th Avenue NW from existing MH 011-233 to the CSO 150/151 diversion structure located on the northwest corner of the West Tunnel Portal site. Overflows from the existing CSO weir structure will be diverted from the outfall pipe and conveyed through the new diversion structure to the tunnel. Approximately 300 feet of 48-inch-diameter conveyance pipe will be used to convey overflows from the outfall pipe diversion point to the tunnel. The new outfall pipe from the diversion structure to a new maintenance hole on the existing outfall will be approximately 140 feet of 36-inch-diameter conveyance pipe. The peak conveyance rate from Basin 150/151 used for sizing pipelines is approximately 60 MGD.

This diversion structure will be a standard pre-cast 12-foot-diameter maintenance hole modified to control flows into the tunnel. A sluice gate mounted on a concrete support wall will be raised and lowered by an electric gate actuator located above ground. An adjustable weir will separate the tunnel flow channel from the outfall pipe; when the water level rises above the weir a CSO event will occur. A removable baffle for floatables may be located in the outfall chamber. The baffle would prevent floatables from discharging into the Ship Canal during CSO events.

Access to the diversion structure will be provided via a standard maintenance hole located above the access bench on the tunnel flow side of the structure. The electric gate actuator will be located above ground, allowing routine maintenance without entry into the structure. A security fence will be constructed at the site to protect the gate actuator from vandalism. Backup power to equipment associated with the replacement Outfall 151 will be provided by the diesel-powered generator at the TEPS and connected by buried electrical conduit from the TEPS to the specific equipment locations.

10.8 Basin 152 Conveyance

The proposed Basin 152 diversion structure is located on 28th Avenue NW, south of NW 56th Street. The rectangular cast-in-place structure will have three channels to direct flow into three conveyance routes. Combined sewer flows will be intercepted from the existing sewer system and flow to the diversion structure upstream (north) of an existing maintenance hole. Dry-weather flows will pass through the diversion structure and continue to existing wastewater system. Approximately 370 feet of 42-inch and 66-inch-diameter conveyance pipe will connect the interception point to the reconnection point for dry-weather flows. The peak conveyance rate from Basin 152 used for sizing pipelines is approximately 109 MGD.

Flows will overtop the first weir and be directed to the tunnel. Tunnel conveyance will start at the diversion structure and extend east along NW 56th Street, turning south on south at 24th Avenue NW and continues to the TEPS at the West Portal. Approximately 2,000 feet of 60-inch-diameter conveyance pipe constructed in an 84-inch-diameter microtunnel will extend from the Outfall 152 diversion structure to a new maintenance hole near the West Portal. The final 200 feet of conveyance to the tunnel drop structure at the TEPS will be constructed using open cut construction. The alignment, pipe sizes, and construction methods will be further refined during the design phase.

When the tunnel has reached storage capacity or the basin control volume has been reached, the gate actuator in the diversion structure will close the sluice gate. The water level will rise to the second weir and flow into the third channel of the diversion structure, which will be connected directly to the existing outfall pipe. Flows entering the third channel will cause a CSO event to occur.

Backup power to equipment associated with Outfall 152 will be provided by the diesel-powered generator at the TEPS and connected by buried electrical conduit from the TEPS to the specific equipment locations.

A grit removal structure may be constructed near 28th Avenue NW between NW 56th Street and NW 57th Street. The structure would be located in the right-of-way and would require approximately 3,000 square feet of construction area. Grit removal requirements in the collection system will continue to be evaluated during final design.

10.9 11th Avenue NW Conveyance

Overflows from the 11th Avenue NW Overflow Structure located at 11th Avenue NW and NW 45th Street will be directed to the 11th Avenue NW Drop Shaft through the proposed diversion structure located on the northeast corner of the intersection. Approximately 50 feet of 72-inch-diameter and 70 feet of 60-inch-diameter conveyance will connect the existing CSO structure to the diversion and drop shaft. An inline buried flow measuring vault will be located along this alignment to measure flows into the tunnel. The peak conveyance rate from the 11th Avenue NW CSO basin used for sizing pipelines is approximately 131 MGD.

The proposed rectangular cast-in-place concrete diversion structure will have a single channel to allow overflows from the existing DNRP CSO structure to pass directly into the tunnel. Sluice gates will be used to control or stop flow into the tunnel. Gate actuators could be hydraulic or electric-type, as determined in final design.

When the tunnel is at capacity or the basin's control volume has been reached, the diversion structure sluice gate will close, allowing the water level to rise and overtop the weir, causing a CSO event to occur. Flows will exit the structure via approximately 10 feet of 72-inch-diameter conveyance pipe connecting to the existing outfall line approximately 100 feet south of the existing 11th Avenue NW CSO Overflow Structure.

10.10 3rd Avenue W Conveyance

Overflows from the existing DNRP 3rd Avenue W Overflow Structure will be diverted from the existing outfall pipe downstream from the overflow structure. The beginning of the proposed diversion will include a drop maintenance hole located in 3rd Avenue W. Flows will drop through this maintenance hole and be directed to a new diversion structure located in a parking area adjacent to the Ship Canal trail on property currently owned by the City. The conveyance alignment continues to the proposed South 3rd Avenue Drop Shaft in the parking lot of the West Ewing Street Mini Park. Approximately 90 feet of 60-inch-diameter conveyance pipe will connect the new diversion structure to the drop shaft. Flows will enter the drop shaft and continue to the South 3rd Avenue W/ 174 Drop Shaft through approximately 650 feet of 18-inch and 42-inch-diameter

conveyance pipe installed in a 96-inch-diameter microtunnel constructed under the Ship Canal. The peak conveyance rate from the 3rd Avenue CSO basin used for sizing pipelines is approximately 72 MGD.

The proposed cast-in-place concrete diversion structure will have a single channel allowing overflows from the 3rd Avenue W CSO Overflow Structure to pass directly into the tunnel. Gate actuators could be hydraulic or electric-type, as determined in final design.

Sluice gates will be used to control or stop flow into the tunnel. When the tunnel capacity is reached or the basin's control volume is reached, the new diversion structure sluice gate will close, allowing the structure to fill with water until overtopping an adjustable weir. Water will enter the outfall chamber and exit the structure via the existing outfall pipe, causing a CSO event to occur.

10.11 Basin 174 Conveyance

A new concrete diversion structure will be located south of an existing diversion structure on 2nd Avenue NW. This diversion structure will convey flows to the King County siphon during normal conditions. During overflow conditions, the diversion structure will convey water to pass to the tunnel. When the tunnel is full or the basin's control volume has been reached, the gate actuator closes the sluice gate and the structure fills until water overtops the weir and a CSO event occurs.

The outfall pipe alignment from the Outfall 174 overflow structure will extend south along the edge of the DNRP Fremont Siphon Odor Control Facility property and connect to a new maintenance hole planned as part of the Fremont Siphon Replacement project that is currently under construction. Approximately 120 feet of 36-inch to 48-inch-diameter conveyance pipe will connect the Outfall 174 diversion structure to the outfall. An inline buried flow measuring vault will be located along this alignment to measure flows into the tunnel. The peak conveyance rate from Basin 174 used for sizing pipelines is approximately 16 MGD.

The proposed Outfall 174 diversion structures will be accessed via maintenance holes with weir walls and flow channels installed. Normal flows will pass directly through the structure and continue to treatment. Overflows will overtop the weir and be directed to the Outfall 174 diversion structure and on to the tunnel/outfall conveyance.

Gate actuators could be hydraulic- or electric-type, as determined in final design.

10.12 Basin 147 Conveyance and Pipe Storage

Basin 147 basin is divided into two sub basins with separate conveyance: 147A and 147B. The proposed conveyance system may start at a new Overflow Structure 147B

located north of the intersection of Woodland Park Avenue and N 35th Street and upstream of an existing maintenance hole. The alignment would follow N 35th Street east to the intersection of Stone Way N, where two other proposed overflow structures would divert overflows from Sub Basin 147A. Overflow Structures 147A-1 and 147A-2 may be located at existing maintenance holes. The conveyance alignment would continue east on N 35th Street to the East Portal. Approximately 430 feet of 24-inch-diameter and 490 feet of 30-inch-diameter conveyance pipe would comprise the total Basin 147 conveyance pipelines. The peak conveyance rate from Basin 147 used for sizing pipelines is approximately 33 MGD.

The overflow structures will be of a similar design; each structure will be a maintenance hole with an external pre-cast concrete vault to house the gate actuator. A sluice gate will be attached to the maintenance hole wall in the dry-weather flow channel. Dry-weather flow will pass directly through the structure in the flow channel. Overflows will pass over an adjustable weir and enter the tunnel conveyance pipeline. Under normal conditions, the sluice gates will be partially closed to a predetermined hydraulic set point that allows only the dry-weather flows to pass through the structure. Wet-weather events will back up and overtop the weir to the conveyance to the East Portal. When the tunnel is full or the basin's control volume has been reached, the gates will open completely, allowing the main pipelines to flow full and overflows to be directed to the existing Basin 147 outfall pipe via the existing downstream overflow structures.

As part of the recommended option, approximately 50,000 gallons of storage may be required in the lower part of Basin 147 to achieve regulatory compliance. Approximately 280 feet of existing 24-inch-diameter gravity pipe will be replaced with 66-inch-diameter conveyance pipe and larger maintenance hole installed with a control gate and weir. During a rainfall event, the gate will close and store approximately 50,000 gallons. Once the additional volume has been stored, the weir will overtop and flow will continue to the existing Basin 147 collection system.

Final design may provide an alternative conveyance strategy with flows intercepted at the outfall pipe and diverted to tunnel by gravity or pumping.

10.13 Operational Modes

Six operational modes are identified by SPU and DNRP as part of the Ship Canal WQ Project Facility Plan development. These modes are described in detail below with specific steps and operational activities. The intent of the operational modes described herein is to operate the storage tunnel system by relying on an automated network of gates, instruments and controls with direct operator supervision and interagency communication and cooperation (including data-sharing) to meet the regulatory requirements for CSO reduction for the targeted SPU and DNRP CSO basins.

DNRP and SPU are developing an O&M plan in accordance with the signed JPA. The operational modes described in this section will be further refined in the final O&M plan. Additional control modes that will be evaluated and refined during the final design phase include modes for tunnel inspection and full storage (tunnel is full but not draining).

10.13.1 Mode 1: Tunnel Filling

During tunnel filling, automated gates at secondary diversion (interceptor) structures will be in their opened position, allowing flows to enter the tunnel. As water levels rise in the combined sewer system, primary weirs at existing DNRP overflow diversion structures and new SPU diversion structures will overtop with combined sewer flows. Flows will enter the storage tunnel at each of the portal locations through the new diversion conveyance systems and the storage tunnel will begin to fill. Instruments at each interceptor structure will monitor level/flow to determine flow from each location into the tunnel.

Gates will actuate to stop flows to the tunnel based on the final operating strategy, which may limit inflows based on the storage level in the tunnel, the storage volume allocation for each basin, and/or a rate-of-rise threshold. A secondary level monitoring and control system at the TEPS wet well will provide an “all stop” water elevation set point and will also close the gates once the water in the wet well reaches that elevation. When gates are in the closed position, this will cause the overflow weirs at diversion structures to overtop, sending combined sewer flow to existing outfalls. If rain continues, combined sewer flows will discharge from existing CSO outfalls. During final design, SPU and DNRP will further develop the operational strategy for tunnel filling to maximize the use of the tunnel storage capacity.

10.13.2 Mode 2: Tunnel Draining

During tunnel draining, water level instruments in DNRP’s North Interceptor (location to be determined during final design, near DNRP’s Fort Lawton Tunnel, upstream of West Point) will indicate that the North Interceptor can accept flows from the storage tunnel without creating negative conditions at the West Point Treatment Plant and any intermediary DNRP facilities. Additional monitoring of DNRP facilities, including the Ballard Regulator Station, may be required to further define the pumping limits during tunnel draining. These requirements will be refined during final design.

10.13.3 Mode 3: Tunnel Cleaning

Tunnel cleaning will begin once the wet well is dewatered and there is available capacity in the downstream DNRP system (including the Ballard Regulator Station and North Interceptor). Instruments measuring the wet-well level will provide a signal to the system control center and the control gate at the East Portal will open. The control gate will

release stored sewage that will travel the length of the tunnel, resuspending any solids collected in the invert of the tunnel and washing this material to the TEPS wet well.

When the water level in the wet well has stabilized following the flushing wave, the secondary wet-well dewatering pumps will start pumping the accumulated material and sewage to the local SPU sewer.

10.13.4 Mode 4: Standby Mode

In standby mode, the system will be ready to accept flows from the combined sewer basins. All of the motor-actuated gates at the interceptor structures will be in the open position. The tunnel may experience infiltration through joints or cracks over time during standby mode. The secondary wet-well dewatering pumps will pump groundwater that infiltrates into the tunnel to the local SPU sewer once a predetermined water elevation in the wet well has been reached.

10.13.5 Mode 5: Continuous Operation (Filling/Draining)/System Optimization

Under continuous operation, the storage tunnel and TEPS will receive continuous data from the DNRP North Interceptor level instrument and flow/volume information from each of the combined sewer basin diversion structures. This mode will be further evaluated in final design to determine an optimized strategy that addresses back-to-back storm events and how tunnel draining must be stopped or proceed at a reduced pumping rate.

This operational mode will rely on extensive real time controls in SPU's and DNRP's systems and interagency communication and cooperation, using shared data, and will allow for eventual optimization of CSO management for each of the connected CSO basins. The O&M plan to be developed by DNRP and SPU per the JPA will describe the optimization process and any procedures related to control logic decision making.

10.13.6 Mode 6: Manual Control

Under manual control mode, the SPU operator will modify system controls from automated to manual control mode. The operator could selectively open and close control gates and adjust the duration and pumping rate of the TEPS pumping systems. The SCADA system interface will provide the operator with applicable level information to help control the system to prevent overflows. The control set points will continue to generate alarms when the storage tunnel approaches and reaches its fill level and when flows overtop weirs. SPU will implement appropriate control actions for the following situations:

- Power failure and restoration

- Communications failure and restoration
- Programmable logic controller self-diagnostics alarms and restoration
- Level and flow measure calibration, out of range (high and low), and restoration
- Set point entry range checking

10.14 Sizing

Hydraulic modeling provided the basis for the estimated volume required for storage tunnel and sizing of the conveyance system. Chapter 6 describes the hydraulic modeling. Table 10-1 summarizes important hydraulic conditions and design flow rates for both the existing system and the system after the proposed changes. Table 10-2 provides major project dimensions and sizes. The values presented in these tables will be updated during final design.

Table 10-1. Design Flows and Hydraulic Conditions

System Operating Parameter	Approximate Value
NIRR to North Interceptor (TEPS average pumping rate)	32.0 MGD
Minimum storage volume for Storage Tunnel	15.24 MG
Basin 152 peak conveyance flow rate	109 MGD
Basin 150/151 peak conveyance flow rate	60 MGD
11th Avenue NW CSO peak conveyance flow rate	131 MGD
Basin 174 peak conveyance flow rate	16 MGD
3rd Avenue W CSO peak conveyance flow rate	72 MGD
Basin 147 peak conveyance flow rate	33 MGD
Minimum flushing wave volume	80,000 gallons

Table 10-2. Sizing of Ship Canal Water Quality Project Facilities

Dimension	Approximate Value	Unit
Storage Tunnel		
Minimum tunnel storage volume	15.24	MG
Tunnel length	14,000	Feet
Minimum tunnel inner diameter	14	Feet
Maximum depth of cover to tunnel crown	Up to 100	Feet
Tunnel Slope	0.25	Percent
West Portal		
Depth (to finished floor for tunneling) – dry-well shaft	Up to 100	Feet
Inner diameter	85	Feet
11th Avenue Drop Shaft		
Depth (to finished floor for tunneling)	Up to 100	Feet
Inner diameter	Up to 15	Feet

Table 10-2. Sizing of Ship Canal Water Quality Project Facilities

Dimension	Approximate Value	Unit
Odor control flow rate	7,000	cfm
Odor control shaft inner diameter	Up to 8	Feet
North 3rd Avenue/174 Drop Shaft		
Depth (to finished floor for tunneling)	Up to 100	Feet
Inner diameter	Up to 32	Feet
Odor control flow rate	12,000	cfm
South 3rd Avenue Drop Shaft		
Depth (to finished floor for tunneling)	Up to 100	Feet
Inner diameter	Up to 25	Feet
East Portal		
Depth (to finished floor for tunneling)	Up to 100	Feet
Inner diameter	Up to 35	Feet
Odor control flow rate	4,000	cfm
Flushing volume storage	80,000	Gal
Tunnel Effluent Pump Station		
Design pump flow rate – primary pump system	16	MGD
Total dynamic head at design point	60	Feet
Number of pumps – primary pump system	2	Each
Pumping rate at design point	32	MGD
Design pump flow rate – secondary pump system	2.0	MGD
Number of Pumps – secondary pump system	3	Each
Pumping rate at design point	2	MGD
Total dynamic head at design point	150	Feet
Odor control flow rate (active)	10,000	cfm
Standby diesel-powered generator capacity at TEPS	Up to 1.5	MW
Standby diesel-powered generator capacity at other locations	up to 100	kW
Footprint of pump station facilities	Up to 72 x 170	Feet

cfm *cubic feet per minute (air flow)*

MW *megawatt*

10.15 Design Life

The basis of design assumes the storage tunnel has a 100-year design life and the primary equipment has a 25-year design life. Routine maintenance of the facility and replacement of equipment will occur as needed to realize the design life.

10.16 Solids Management

The design of the proposed storage tunnel will include a control gate and sewage reservoir for flushing and self-cleaning at the East Portal so that solids will not accumulate in the storage tunnel. However, the tunnel design allows for access and

cleaning through the TEPS wet well and portal/drop shaft structures if necessary to remove additional materials.

The solids management practices for the sewer lines leading to and from the proposed storage tunnel are the same as those SPU currently implements elsewhere in the sewer system. These practices entail accessing the sewer lines via maintenance holes and using a Vactor™ truck to extract solids. The solids are routinely taken to the SPU Haller Lake facility and decanted. The City's solid waste contractor then disposes of the remaining solids.

10.17 Ability to Provide Additional Control Volume

In the unlikely event additional control volume is needed, it could be achieved by one or more of the following options:

- Performing infiltration reduction measures
- Implementing the Residential RainWise Program
- Constructing additional storage in the Ship Canal WQ Project basins

10.17.1 Infiltration Reduction

Due to the age of the collection system in the project area, many pipe segments are likely experiencing infiltration; however, as was found in the *Pilot Project Report: Regional Infiltration and Inflow Control Program* (King County, 2004), the majority of the infiltration is likely occurring in smaller diameter lateral and side sewers on private property. Even when City workers identify sources of infiltration, such as leaking pipe joints, quantifying the flow rate of groundwater that leaks into the sewer during wet weather can be extremely difficult. Infiltration reduction projects are unreliable in achieving specified reductions of flow required for CSO control because predicting or measuring the anticipated or achieved reduction level can be difficult.

Other combined sewer agencies across the nation, including others in the Northwest, consider infiltration reduction a good asset management practice but do not rely upon the reduction of flow to achieve CSO reduction requirements. SPU frequently performs the types of construction typically associated with infiltration reduction, such as cured-in-place pipe lining, to protect the structural integrity of the pipeline or remove obstructions such as roots. Infiltration reduction is usually a secondary benefit of rehabilitating the pipe. SPU considers reducing infiltration an ongoing effort to maintain a reduced level of combined sewer flows. Any such reduction in the combined sewer flows helps ensure the facility has adequate capacity.

10.17.2 Residential RainWise Program

SPU's Residential RainWise Program could also reduce combined sewer flows within the basin. The program aims at reducing the amount of stormwater runoff from private properties into the storm drainage system and sewer collection system. Removing residential stormwater connections from the combined system reduces the volume and flow rate of wet-weather peak flows.

10.17.3 Construct Additional Storage

If the storage tunnel was determined to need additional capacity, supplemental storage could be added by constructing a connecting tunnel or tank storage in the project area, depending on the storage volume needed. Additional analysis will be required to determine the preferred option.

10.18 Estimated Operations and Maintenance Staffing Needs

The O&M strategic direction of the recommended option is as follows:

- Design the system to “Keep It Simple” for O&M.
- Design tunnel and pipes to be maintainable from ground surface whenever possible.
- Provide for entry and maintenance.
- Monitor the system during operations to indicate when proactive maintenance is required to ensure the system functions properly.

SPU will perform regular maintenance to meet the design life of the facility and ensure proper operation, including required instrument calibration. Table 10-3 shows the types of O&M activities that could occur, the frequency of each activity, and staffing requirements to perform those activities. The list includes normal inspection and maintenance activities. Minor repairs, cleaning, adjustments, and needed replacement of minor components will be part of those activities. Major repair or replacement of structures, equipment, and systems are not included. A future O&M Plan to be developed by both agencies per the JPA will supersede the assumptions shown.

**Table 10-3 Routine Operation and Maintenance Activities for
Ship Canal Water Quality Project Tunnel**

Frequency	Typical Activities	Equipment and Staff	Impacted Area
Quarterly	Inspect differential pressure indicated by the gauges on the mist/grease filter and carbon beds in odor control units; Replace and clean the fouled filter pads as needed.	Service truck and 2 staff	Right-of-way areas where access to buried structures requires lane closures Outside activities at the TEPS facility will generate noise to the adjacent parcels for the duration of work.
	Exercise valves, motor-operated gate, and pumps in facilities vault.		
	Inspect debris build-up on walls and weirs and clean as necessary.		
	Inspect landscaping and maintain grounds at TEPS.		
	Calibrate instruments at required locations based on schedule.		
	Inspect and maintain indicator lights, displays, pressure gauges, and monitoring equipment.		
Annually	Inspect mechanical and electrical equipment for wear and corrosion.	Service truck and 2 staff	Right-of-way areas where access to buried structures requires lane closures Activities for the annual maintenance could be performed in conjunction with quarterly inspection activities (requires an additional service truck and 2 staff). Outside activities at the TEPS facility will generate noise to the adjacent parcels for the duration of work.
	Inspect and maintain heating-ventilation-air-conditioning supply/exhaust, and odor control fans.		
	Collect carbon sample or use the carbon sampling probe to check the carbon media life.		
	Remove and inspect secondary wet-well dewatering drain pumps (offsite servicing).		
	Test and certify backflow prevention device.		
	Test standby diesel-powered generator system.		
	Replace carbon media.		
	Remove and inspect dry-well sump pumps (offsite servicing).		
Annually	Clean conveyance piping for connected overflow diversion pipes at each portal and drop shaft location.	Service truck, Vactor™ truck, and 4 staff	Right-of-way areas where access to buried structures requires lane closures

**Table 10-3 Routine Operation and Maintenance Activities for
Ship Canal Water Quality Project Tunnel**

Frequency	Typical Activities	Equipment and Staff	Impacted Area
	Clean effluent discharge piping.	Service truck, Vactor™ truck, and 4 staff	Right-of-way areas where access to buried structures requires lane closures
Infrequent (every 5 to 25 years)	Replace mechanical equipment (valves, pumps, piping).	Service truck, Vactor™ truck, and 4 staff	Right-of-way areas where access to buried structures requires lane closures
	Inspect microtunnel.	Specialty Equipment or subcontractor	
	Inspect structure of storage tunnel and drop shafts/portals.	Service truck and 2 staff	Right-of-way areas where access to buried structures requires lane closures
	Inspect flow-monitoring vault and equipment.	Service truck and 2 staff	Right-of-way areas where access to buried structures requires lane closures
Very Infrequent (every 25+ years)	Replace large equipment at TEPS.	Service truck and 3 staff	Inside TEPS Facility
	Perform seismic Inspections.	Crane, semi- truck, service van, 3 to 10 staff	Right-of-way areas where access to buried structures requires lane closures
	Repair tunnel, portal, drop shafts, and diversion structures.	2 Service trucks and 6 to 10 staff	Right-of-way areas where access to buried structures requires lane closures

10.19 Design Parameters

10.19.1 Site Selection

Site selection was initiated as part of the SPU LTCP (Volume 2 of the *Plan to Protect Seattle's Waterways*; SPU, 2015a). Sites for the tunnel portals and CSO diversion structures were identified as part of this process. This facility plan refined the locations to those described and shown herein. Conveyance alignments were generally identified as well as part of the SPU LTCP (SPU, 2015a) and refined as part of this facility plan.

10.19.2 Site Design

The finished site design for sites inside and outside of the right-of-way must provide adequate access, working space, and parking for maintenance of the system. Minimizing impact to existing on-site and adjacent land uses is an important project site design parameter.

10.19.3 Construction/Earthwork

Shoring for earthwork will be of a type appropriate for the available space on the site or in the right-of-way and other site conditions. Shoring for earthwork must adequately support the sides of the excavation and protect adjacent areas and structures.

10.19.4 Structural/Geotechnical

Additional geotechnical borings were completed between February and September 2016 along the tunnel alignment and at key facility locations and are currently being analyzed.

The tunnel will be constructed in a mixture of very dense or hard glacially overconsolidated glacial till (gravel, sand, and silt), outwash (sand and gravel), and interglacial fluvial (sand and gravel) and lacustrine deposits (silt and clay). Groundwater pressures along the tunnel invert will be between 3.5 to 5 bars, depending on final tunnel depth. The access shafts will be constructed through similar soils, but will also encounter looser and softer soils near the ground surface. The potential for liquefaction and lateral spreading exists at three of the shaft locations. Additional analysis will be required during the final design to better define the risk and need for mitigation.

Pressurized-face tunneling methods, along with gasketed segmental liners, will be required to resist groundwater and soil pressures. The shaft excavations will likely require relatively tight shoring with dewatering, excavation in the wet, and tremie slabs, or ground improvement, to provide a stable excavation base.

10.19.5 Stormwater

Stormwater design will follow the City's Stormwater Code for onsite stormwater management water quality treatment of runoff and flow control where required. The design flow rate is the rate at or below which 91 percent of the total runoff volume for the simulation period is treated (Seattle Municipal Code 22.805.090.B1). The stormwater design also will incorporate onsite stormwater management , including the use of amended soils, permeable surfacing, bioretention planters, or some combination of these elements. This option may include runoff reduction methods of permeable pavement and amended soils. These improvements will infiltrate direct precipitation, remove pollutants, reduce runoff, and reduce the size of future drainage facilities. Additional site-specific soils analysis is required as part of evaluating and selecting onsite stormwater management strategies.

The option will incorporate the following design approaches. A detailed assessment of the drainage systems in the project basins will be completed as part of the final design.

10.19.5.1 West Portal Site

Runoff from the West Portal site generally flows south towards Salmon Bay. The existing site stormwater system will be demolished during construction. The portion of the site that will accommodate the TEPS facility will be paved or graded to direct runoff to on-site water quality treatment facilities including filter planter boxes, bioswales or other treatment technologies. Other onsite stormwater management strategies for the parcel could consist of a porous sidewalk/driveway surfaces around the facility. These surfaces will infiltrate direct precipitation, reduce runoff, and reduce the size of future drainage facilities. Runoff from the West Portal site will be discharged to the Ship Canal through SPU's rehabilitated Outfall 151.

10.19.5.2 11th Avenue Drop Shaft Site

Runoff from the 11th Avenue Drop Shaft site will remain in the existing right-of-way by using grading and curb and gutter to direct flows to existing drainage structures. Onsite stormwater management strategies for the site could consist of a porous sidewalk in the disturbed area or adding treatment systems (e.g., Filterra units or comparable technologies) to treat runoff.

10.19.5.3 North 3rd Avenue/174 Drop Shaft Site

Runoff from the North 3rd Avenue/174 Drop Shaft site will remain in the existing right-of-way by using grading and curb and gutter to direct flows to existing drainage structures. Onsite stormwater management strategies for the site could consist of a porous sidewalk in the disturbed area or adding treatment systems (e.g., Filterra units or comparable technologies) to treat runoff.

10.19.5.4 East Portal Site

Runoff from the East Portal site generally flows south and eastward towards the north end of Lake Union. The existing site stormwater system will be demolished during construction. The site will be paved or graded to direct runoff to on-site water quality treatment facilities including filter planter boxes, bioswales or other treatment technologies. Other onsite stormwater management strategies for the parcel could consist of a porous sidewalk/driveway surfaces around the facility.

10.19.6 Architecture and Landscaping

At the West Portal site, an above-grade building is proposed. Design elements such as exhaust stacks, intake and exhaust units, and other exposed above-grade features will be designed to be compatible with the existing site's aesthetic characteristics. At the East Portal site, a small above-grade building is also being proposed. Design elements will be reviewed with stakeholders and will blend with the neighborhood architectural fabric.

10.19.7 Operations and Maintenance and Facility Inspection Considerations

An important design objective is for simple and reliable operation and low maintenance. This includes avoiding the need to enter the storage tunnel to perform regularly scheduled O&M activities by including a post-event solids removal system. The storage tunnel flushing system will have automated operation. Scheduled maintenance will require entry into the East Portal to inspect the flushing system control gate.

The design will allow access for personnel and equipment to enter the storage tunnel and portals. For example, the design will incorporate removable concrete panels to allow large equipment to be placed inside and removed from the storage tunnel via the portals. Access hatches for scheduled O&M activities will have fall protection grating. SPU will develop additional O&M procedures for the tunnel, portals and flushing system as needed during final design. The TEPS wet well, storage tunnel, and drop shafts/portals are not planned for full occupancy, and are therefore considered confined spaces. SPU will implement confined space entry procedures before entering these structures. The TEPS dry well and electrical and mechanical vault at each of the drop shaft/portal sites are planned for full occupancy and will include appropriate life safety systems (e.g., ventilation, lighting, access provisions) to meet current code requirements.

SPU's O&M personnel will monitor the overall facility remotely during operation to verify that the mechanical, electrical and instrumentation and controls systems are working properly

The TEPS facility O&M and inspection will follow SPU's current practices for pump stations and CSO facilities. SPU is currently establishing O&M procedures for odor

control systems recently constructed at other CSO storage facilities. SPU will develop additional O&M procedures as needed during final design and document these in the O&M plan per the JPA.

10.20 Feasibility of Implementation

Based on an evaluation of engineering, hydraulics, construction, O&M, and environmental aspects, implementation of the Ship Canal WQ Project Tunnel option appears to be feasible with no fatal flaws. King County will participate in the Ship Canal WQ Project based upon an approved Consent Decree modification and the signed JPA.

10.21 Environmental Impacts

SPU evaluated the Ship Canal WQ Project option as part of the *Plan to Protect Seattle's Waterways* and the 2014 Plan EIS (SPU, 2015a). To address new and modified project elements, SPU prepared a project-specific SEIS (SPU, 2017). The SEIS addresses new and modified information for the following environmental elements identified by SEPA:

- Earth and Groundwater
- Surface Water
- Air Quality and Odors
- Fisheries and Biological Resources
- Land Use and Shoreline Use and Visual Quality
- Recreation
- Transportation
- Noise and Vibration
- Energy and Climate Change
- Historic, Cultural, and Archaeological Resources

These analyses consist of review of updated information, fieldwork, and modeling.

Project impacts identified in this section will be minimized by implementing proper measures and BMPs that will be defined during final design.

10.21.1 Earth and Groundwater

Construction-related impacts to earth and groundwater would be associated with excavation, dewatering, trenching, tunneling, and the presence of contaminated soil and groundwater.

10.21.1.1 Erosion and Dewatering

Areas that are disturbed during construction will be subject to increased erosion, and erosion control measures will be required.

Dewatering may be required in some locations to prevent groundwater from interfering with construction. However, the project will be designed to require minimal amounts of dewatering. Dewatering during excavation below the groundwater table could result in settlement of nearby structures, roadways, and utilities. However, the potential for impact is considered low if proper measures to minimize and avoid dewatering are used.

10.21.1.2 Contaminated Materials

Potential for encountering contaminated soils during tunnel boring is low because the tunnel will be deep. If contaminated soil is encountered, then it will be managed in accordance with Ecology Model Toxics Control Act (MTCA) and other applicable requirements.

The contamination associated with the West Portal at the Salmon Bay Hotel Group property is documented and would require cleanup under Department of Ecology MTCA requirements. Contaminants detected in soil removed from the East Portal or other construction areas would also be removed in accordance with applicable requirements.

Property acquisition and demolition needs will be determined during final project design, including any specific management requirements under the Asbestos Hazard Emergency Response Act. All contaminated materials will be handled in accordance with applicable requirements and disposed of at an appropriate facility. Removing contaminated materials during construction would benefit human health and worker safety and reduce the risk of future contamination of earth and groundwater.

10.21.1.3 Vibration and Settlement

Based on currently available data, building damage from vibration during tunnel excavation is not anticipated because of the depth of the tunnel. As is typical of tunnel projects, the Ship Canal WQ Project will require excavation that could result in minor ground settlement in localized areas. Where needed, protective measures such as grouting will be used during tunnel boring to prevent or limit settlement. These measures have been successfully used on tunnel projects in the Seattle area. The use of these measures is expected to prevent damage to most buildings and utilities.

Ground settlement could occur in areas where soils are excavated and dewatering occurs. Construction activities, including pile driving and sheet pile installation, could cause vibration and also result in ground settlement. Excessive settlement could impact or apply loads to nearby roadways, rail lines, utilities, and structures. More detailed

analysis will be conducted during project design to determine areas where soils could settle.

If areas were prone to settlement, engineers will propose measures to minimize effects. Any settlement from constructing the portals, drop shafts, or conveyance elements is expected to be minor and would be repaired either during or after construction.

10.21.1.4 *Spoils Disposal*

Based on current plans, an estimated maximum of approximately 409,000 cubic yards of spoils would be generated from site demolition, excavation, foundation installation, and ground improvement activities. An estimated maximum of approximately 275,000 cubic yards will be excavated during tunnel construction, and the remainder of spoils will come from the rest of the project. Spoils that are unsuitable for reuse by the Ship Canal WQ Project will need to be disposed at an appropriate facility. The disposal site will be determined during final project design, but clean soils will be hauled to a permitted approved facility for final disposal.

Potential impacts resulting from disposal of spoils include erosion and sedimentation where excavated materials are stored onsite or if they are spilled during transport. These impacts will be evaluated and mitigated during final design.

Transport of spoils by rail car, barge, and truck could result in dust deposited on roadways, rail corridors, or water. Covering of loads during hauling will reduce dust. Some of the excavated soil will originate from areas where known or suspected contamination has been identified. Soils will be tested during construction to determine if they are contaminated. If they are contaminated, they will be transported in accordance with applicable containment and transport methods to an approved disposal site.

Operational impacts on earth and groundwater resources would be minor, and removing contaminated material would benefit soil and groundwater quality.

10.21.2 Surface Water

The overall construction effects on surface water resources could include increased turbidity, increased pollutants and sediments entering stormwater runoff, and increased risk of pollutant spills. BMPs will be implemented to reduce the potential for these effects, in accordance with City of Seattle requirements. Additionally, a Stormwater Pollution Prevention Plan and a Construction Stormwater and Erosion Control Plan will be prepared to ensure that measures are in place to protect water quality, prevent erosion and sedimentation, and manage activities and potential pollutant sources.

Project operation is anticipated to result in substantial water quality benefits in the Ship Canal because the number and volume of CSO discharges will be reduced.

10.21.3 Odor and Air Quality

The Ship Canal WQ Project would cause short-term, minimal to moderate localized effects on air quality during construction activities. Construction air quality impacts adjacent to construction sites would relate to dust from disturbed soils and odors and emissions from operating heavy-duty diesel and gasoline-powered equipment, earth excavation and grading, handling and transport of excavated material, and truck trips. Use of heavy equipment and trucks would end once construction is complete, but would take place over several years in some locations. Sewer odors could also be temporarily emitted where existing sewer pipes or vaults are opened during construction. Construction BMPs would minimize impacts.

The Ship Canal Tunnel will be designed to minimize the generation of odors by using state-of-the-art odor control facilities at locations where odors could be released to the atmosphere. The project includes a system-wide odor control system equipped with automated cleaning systems and odor control systems with carbon scrubbers, mist and grease filters, and fans. Additional odor control systems, which include carbon scrubbers and filters, will be installed at the drop shafts to allow air vented from the tunnel during filling to pass through the carbon media for treatment before discharge to the environment.

10.21.4 Fisheries and Biological Resources

For most of the project, any disturbance of terrestrial habitat would occur on paved or developed areas. Vegetated areas in this urban setting are disturbed but may provide some habitat to urban wildlife. Impacts to vegetated areas would be limited and would have minimal effect, given the adaptability of wildlife living in these areas.

In-water work related to pier reconstruction, barge use, and potential outfall replacement could cause short-term, localized turbidity plumes; underwater noise and vibration; and increased underwater shading from moored work barges. Any temporary effects are not considered significant. The project area provides poor salmon habitat. While salmonids migrate through the area, the Ship Canal is unlikely to be used extensively by salmonids for holding and foraging. In Salmon Bay, near the West Portal site, the shoreline is lined with docks providing long-term and active boat moorage and there is very little riparian or upland vegetation. Adult salmonids migrate into the Ship Canal from Puget Sound through the Ballard Locks or the fish ladder at the Locks. Adult salmonids tend to migrate fairly quickly through the Ship Canal, with an average passage time of 1 to 4 days depending on species. Juvenile salmonids outmigrate through the Locks and fish ladder, but can also travel via culverts used to divert fresh water into the Locks, the smolt passage flumes, or the spillway gates.

Chinook salmon smolts usually take 1 to 4 weeks to pass through the Ship Canal whereas sockeye and coho salmon take less than one week. Adult outmigrating salmon, in particular Chinook salmon, often hold just upstream from the Locks in a cool water refuge near the saltwater drain before going through the Locks.

Nevertheless, all in-water work will be conducted during the work window approved by the Washington Department of Fish and Wildlife and BMPs will be implemented to minimize impacts to fish and other aquatic species (City of Seattle, 2013). Impacts to fish and fish habitat would be temporary and minimal because in-water work will occur when salmonid species are least likely to be present. SPU will work with affected Tribes to minimize impacts to Tribal fishing, and the timing of in-water work will be restricted to minimize impacts on tribal fishing. Tribal concerns regarding potential impacts to Tribal fishing would be addressed during the Corps of Engineers permitting process.

Impacting aquatic habitats from construction site runoff or in the unlikely event of construction equipment spills is a risk. However, impacts would be minimal by implementing required BMPs, as well as a Stormwater Pollution Prevention Plan and a Construction Stormwater and Erosion Control Plan.

After completion, the Ship Canal WQ Project will have a long-term beneficial effect on fish and other aquatic species due to less discharge of combined sewage. Stormwater runoff that enters the combined sewer system will be treated before discharge to Elliott Bay rather than discharged to the Ship Canal, and the tunnel will reduce CSOs from existing Ship Canal outfalls to no more than one per year on a 20-year moving average, thus improving water quality in the Ship Canal. Replacing the existing creosote-treated timber piles supporting the pier at 24th Avenue NW will reduce a contaminant source in the Ship Canal. The reconstructed pier will also have fewer piles than existing, and will likely include grated decking for increased light penetration to minimize impacts to fish and aquatic habitat.

10.21.5 Land and Shoreline Use and Visual Quality

Potential construction-related impacts on land and shoreline use and visual quality are associated with acquisition of property and easements, incompatibility of surrounding land uses, changes to views, and light and glare.

10.21.5.1 Acquisition of Property and Easements

Temporary and permanent easements from some private landowners will be needed to construct the project. This will include a “tunnel envelope” that provides a horizontal and vertical offset to protect the tunnel from future surface and subsurface development. This envelope will generally extend 20 feet from the top, bottom, and sides of the tunnel. Permanent easements for the tunnel envelope will be negotiated with private property

owners where the envelope extends outside the public right-of-way. This routing was developed to reduce impacts to private property in the unlikely event a tunnel machine intervention should be required during construction.

Temporary construction easements may be needed from adjacent property owners for the West Portal. Depending on the final design of the 24th Avenue NW pier, several potential temporary property-related impacts could occur, including extending the reconstructed pier, displacing existing recreational and live-aboard boat moorage at the adjacent pier to the east, displacing the commercial pier use to the west, and using extra-long or double barges, protruding further into the Ship Canal waterway and potentially affecting waterway use.

A limited number of temporary construction easements will likely be required for construction activities or staging areas associated with constructing the drop shafts and conveyance located outside of public rights-of-way.

Some relocations will be required; the City will follow applicable requirements for property acquisition, compensation and relocation.

10.21.5.2 *Incompatibility of Adjacent Land Uses*

Use of the 24th Avenue NW pier for barging operations near the West Portal will cause conflicts with adjacent mooring piers, requiring temporary displacement or relocation of moorage. The use of tugs and barges will increase the use of the Ship Canal waterway but this increase in vessel traffic will not be significant.

Use of both rail and barges to haul materials and tunnel spoils is under consideration. Both of these options could have potential impacts and could be incompatible with recreational uses during the construction period.

10.21.5.3 *Changes to Visual Character*

Construction will temporarily affect visual character through short-term changes to views resulting from construction equipment and activities. Given the industrial character in the vicinity of the West Portal and pier, the temporary presence of the conveyor structure and use of large barges would not be a significant visual impact.

10.21.5.4 *Light and Glare*

Nighttime construction could be necessary for project components, resulting in light and glare impacts. Temporary lighting impacts during nighttime construction would be reduced by shielding light sources to block direct views from residential areas, and by aiming and shielding light sources to reduce spillover lighting from such areas as necessary.

After construction, permanent underground easements will have no material impact on the normal use and enjoyment of the affected properties. The former Yankee Diner building will remain in place to be sold or repurposed. The 24th Avenue NW pier will be reopened for public access. A portion of the East Portal site is anticipated to remain in City ownership following project completion. Permanent easements for the two intermediate drop shafts will not interfere with existing site uses or access. No significant impacts to land and shoreline uses are expected at West Ewing Mini Park after construction. The presence of drop shaft facilities will result in a dedicated use of the subsurface area and will restrict certain future uses in the surface area above the facilities. The area is currently used for parking, and redeveloping it to a different use is not planned.

The project's consistency with Seattle's Comprehensive Plan is the same as stated in the 2015 Plan EIS. The regulatory environment, specifically City of Seattle Land Use Code and SMP described in Section 4.8 of the 2015 Plan EIS, has not substantially changed. However, Ecology approved Seattle's SMP Update on June 1, 2015, and put it in effect on June 15, 2015. No substantive changes to standards applicable to utility services and utility lines in the approved SMP Update have been made compared with the version of the SMP Update that was reviewed at the time the 2015 Plan EIS was issued.

10.21.6 Recreation

Construction-related impacts can occur when construction is within or adjacent to a park or in a right-of-way.

10.21.6.1 West Portal

The existing pier at the 24th Avenue NW street end will be closed to recreational use for up to 4 years. Because other nearby public docks will remain open, and recreationists will be able to utilize alternate nearby facilities, this impact would not be significant. The proposed Threading the Needle Park project could not begin until the Ship Canal WQ Project is complete and the pier is no longer being used to convey tunnel spoils. However, no funding or schedule for implementing the Threading the Needle Park project is currently available. Therefore, constructing the Ship Canal WQ Project likely will not delay the park project.

Recreational users of the Ship Canal include paddle boarders, kayakers, and recreational boat users. They will likely notice construction noise and activity associated with pier construction and barging operations, but noise and activity levels would be consistent with the types of noise and activity that currently occur along the industrial shoreline.

10.21.6.2 *Drop Shafts and Conveyance*

Construction will potentially require temporary closure and rerouting of portions of the Burke-Gilman Trail during the 12- to 15-month construction period. Construction activities will need to be coordinated with the Burke-Gilman Trail Missing Link project construction.

Some construction activities will likely occur within Fremont Canal Park. The actual location of the drop shaft will be determined during final design. If located in the park, construction areas within the park will be fenced, and most of the park will remain available for recreational use.

Construction will likely occur in a portion of the paved parking lot of West Ewing Mini Park. During the approximate 6- to 9-month construction period, recreationists using West Ewing Mini Park will still have access to the park, but the construction area will be fenced. Park users will still be able to access the overlook, lawn areas, picnic tables, and benches during construction. However, park users will be aware of construction noise, dust, the high visibility of construction activities and fencing, and increased traffic on adjacent roads from construction truck trips.

Construction will likely occur adjacent to the Ship Canal Trail and recreation areas along the Ship Canal associated with the trail (including lawn areas and benches). During the approximate 6- to 9-month construction period, recreationists will still be able to access the trail. However, trail and park users will be aware of construction noise, dust, the high visibility of construction activities and fencing, and increased traffic on adjacent roads from construction truck trips.

Construction activities will likely also be located in the vicinity of athletic facilities at Seattle Pacific University. The Royal Brougham Pavilion will be within 150 feet of construction, and Wallace Athletic Field will be within 300 feet of construction. Construction activities will be visible and potentially audible from Wallace Athletic Field.

10.21.6.3 *Construction in a Right-of-Way*

Construction in road rights-of-way would temporarily interfere with informal recreation opportunities such as bicycle and pedestrian use. For the Ship Canal Project, drop shaft construction and associated conveyance activities could disrupt bicycle and pedestrian use on streets over the approximate 12- to 24-month construction period in each neighborhood. Due to the availability of alternate routes, this disruption would not be considered significant.

10.21.6.4 *Hauling of Tunnel Spoils*

An estimated maximum of 275,000 cubic yards of tunnel spoils (and approximately 70,000 cubic yards of soil excavated for shaft construction) will need to be hauled away

from the West Portal site. Tunnel spoils will be hauled through a combination of three methods: barge, train, or truck. Most tunnel spoils likely will be hauled by barge or rail car. Depending on how the pier and barges are configured, the barges could encroach on navigation in the Ship Canal, impacting recreational canal use. Additionally, barges could preclude moorage at adjacent privately owned piers. Train traffic could cause periodic short access delays to the Burke-Gilman Trail and 11th Avenue NW, 14th Avenue NW, and 28th Avenue NW, as well as to the Ballard Locks. Bicyclists despite a high number of existing truck trips on the road and entering and exiting driveways already frequently use Shilshole Avenue NW. Therefore, bicycle use of Shilshole Avenue NW will likely not be disrupted by truck trips for this project. However, added truck trips could increase potential safety conflicts along Shilshole Avenue NW.

After construction, the project will reduce pollutant loading to the Ship Canal, with potential long-term benefits to water-based recreation. Operational impacts will be limited to those areas where permanent facilities associated with the Ship Canal WQ Project are located in or adjacent to parks at the West Portal location, the South 3rd Avenue drop shaft, and the North 3rd Avenue Drop Shaft. The 24th Avenue NW pier will be reopened for public access. The new concrete pier will have a modern design for pedestrian use and boat tie-off.

10.21.7 Transportation

Most transportation impacts would be construction-related, including disruption to vehicular and non-motorized traffic at roadways, sidewalks and trails where construction occurs, displacement of parking, and potential increases in vehicular traffic generated by construction activities. Transportation impacts during construction would include temporary roadway lane and sidewalk narrowings or closures adjacent construction activities. Some closures could require temporary detours of vehicular, transit, or non-motorized traffic.

If Ballard Conveyance is constructed via NW 54th Street, transportation impacts would be considered significant and unavoidable unless measures could be implemented to maintain adequate access to adjacent businesses during construction.

Construction-generated truck trips likely will not significantly affect roadway operations, but likely will be noticeable. Use of barge or rail to support construction activities where feasible would reduce truck trips.

Increases in train traffic during construction may require measures to minimize the potential conflict with other vehicular or non-motorized traffic.

Measures to reduce or eliminate potential construction impacts include general measures to avoid or reduce vehicle queues and delay near construction activity,

maintaining vehicular and non-motorized access along roadways disrupted by construction, as well as to adjacent businesses and residences, coordinating with agencies with jurisdiction over the transportation facilities, and coordinating with affected community members.

When constructed, the Ship Canal WQ Project facilities will be located mostly underground and physically separated from transportation infrastructure and services. A small number of operational trips will be generated to support O&M.

10.21.8 Noise and Vibration

Noise generated by construction equipment and activities could impact residential areas and sensitive receptors. Operational noise impacts would be generated by pump stations, odor control facilities, maintenance, and other noise-generating equipment associated with permanent facilities.

Multiple projects, public and private, will be under construction concurrent with the Ship Canal WQ Project. Potential impacts from construction noise will depend upon the type of construction activity on a given day, the equipment used, the distance between construction activities and the nearest sensitive land use, and the existing ambient sound levels near the receptor.

Residential areas near Ballard Conveyance and Wallingford Conveyance have the greatest potential for experiencing intermittent noise impacts.

Vibration impacts such as minor cosmetic damage to structures or annoyance of occupants may occur during concrete demolition and shaft construction.

Once construction has been completed, a pump station will operate at the West Portal and passive odor control systems will operate at the drop shaft locations and the East Portal. Diesel-powered generators at each of the portal and drop shaft locations will be tested for 1 hour each month.

Completed facilities operations must comply with Seattle Municipal Code sound level limits at adjacent property lines. Seattle Municipal Code 25.08.530 exempts sounds generated by emergency equipment and applies to diesel-powered generator testing as long as reasonable noise mitigation is used.

After project completion, vibration impacts are not anticipated. Equipment installed at the pump station, drop shafts, and portal locations are not anticipated to generate vibration levels high enough to cause impacts at nearby receptors.

Constructing the Ship Canal WQ Project may require nighttime construction activities at the West Portal; therefore, a nighttime noise variance may be required from Seattle

Department of Construction and Inspections. Because of the project magnitude, a Major Public Project Construction Noise Variance will most likely be required. In coordination with Seattle Department of Construction and Inspections, measures to reduce the impact of noise will be developed and specified in the noise variance. To reduce construction noise at nearby receptors, measures could be incorporated into construction plans, specifications, and variance requirements. Final measures will be determined as part of permitting during final design. Additional measures could reduce operational noise impacts and may be required to meet Seattle Municipal Code sound level limits and worker safety requirements after the project has been completed. Daytime construction activities are not expected to exceed daytime sound level limits at any project sites.

To reduce vibration impacts produced during construction and operation activities, additional measures could be implemented and will be determined as part of permitting conditions established during final design.

10.21.9 Energy and Climate Change

Constructing the Ship Canal WQ Project will produce greenhouse gases, which contribute to climate change. Greenhouse gas production would primarily be associated with emissions from construction equipment and commuter vehicles, as well as embodied energy. “Embodied energy” is the energy necessary for the entire product lifecycle beginning with raw material extraction and ending with deconstruction or decomposition.

During the 6- to 7-year construction period, diesel-fueled construction equipment will require an estimated 812,608 gallons of diesel fuel. Construction worker personal vehicles will consume an estimated 640,000 gallons of gasoline. The total greenhouse gas emissions from consumption of fuels during project construction will be approximately 9,786 metric tons of carbon dioxide equivalent (CO₂e). The embodied energy required for the project will add approximately 18,841 metric tons of CO₂e. Together, the total greenhouse gas emissions during construction will be an estimated approximately 35,692 metric tons of CO₂e. This impact is considered to be minor considering the total CO₂e emissions in Seattle in 2012 were 3,728,000 metric tons of CO₂e (City of Seattle, 2014). Therefore, constructing the Ship Canal WQ Project will contribute less than 1 percent of Seattle’s annual total greenhouse gas emissions.

An estimated 35,873,760 kilowatt hours of electricity will be required to operate the tunnel boring machine, tunnel lighting and fans, yard lighting, and other construction equipment. This electricity use will be spread across the 2-year construction period of the tunnel, and the daily electric use will be a small percentage of the overall energy consumption in the region. Therefore, the impact would not be significant. SPU O&M

staff vehicles will produce minor greenhouse gas emissions. The associated annual greenhouse gas emissions are an estimated 32 metric tons.

Operating the Ship Canal WQ Project will also use electric power to run pumps and ventilation equipment. Operating the equipment could be energy intensive, but the equipment will operate infrequently, only during and after storm events. The anticipated annual electricity consumed will be approximately 2 million kilowatt hours, an amount not considered significant when compared to energy use in the City of Seattle as a whole.

DNRP's West Point Treatment Plant will receive additional sewage flows that previously were discharged to receiving waterbodies. The effort to convey and treat these additional flows is expected to increase energy consumption at pump stations and the treatment plant by less than 1 percent.

The project energy requirements represent a small portion of the overall regional demand.

10.21.10 Cultural Resources

The project study area is located in the Ballard, Fremont, Wallingford, and Queen Anne neighborhoods of Seattle, and includes approximately 85 historic-age properties. Only two of these are considered eligible for listing in the NRHP. Additionally, there are three historical districts adjacent to, or overlapping portions of the study area. The identified historical properties eligible for listing are not located within these districts.

Project plans will directly impact two unevaluated historic properties. The potentially eligible properties are located adjacent to the West Portal and Ballard conveyance: the Ballard Terminal Railroad alignment and the Stimson Lumber Company Office building. Improvements to the Ballard Terminal Railroad to allow for transportation of project spoils are not expected to cause a significant probable impact. Typically, an NRHP-eligible railroad is not considered diminished if expanded. Construction in the right-of-way in front of the Stimson Lumber Company Office will likely involve increased dust or vibration, but this is not anticipated to be a significant impact. Assessment is recommended for both direct and indirect impacts to historic-aged properties.

In order to comply with Seattle Municipal Code 25.05.675.H, the City-owned public 24th Avenue NW pier, which was built in 1935 and will be directly impacted by the Ship Canal WQ Project, will need to be documented before it can be reconstructed.

Two study areas were considered: an aboveground cultural resources study area and a study area for archeological resources. The study area for aboveground cultural resources includes the locations of the TEPS at the West Portal, above-grade diesel-powered generator housing at the East Portal, and associated open-cut excavations at

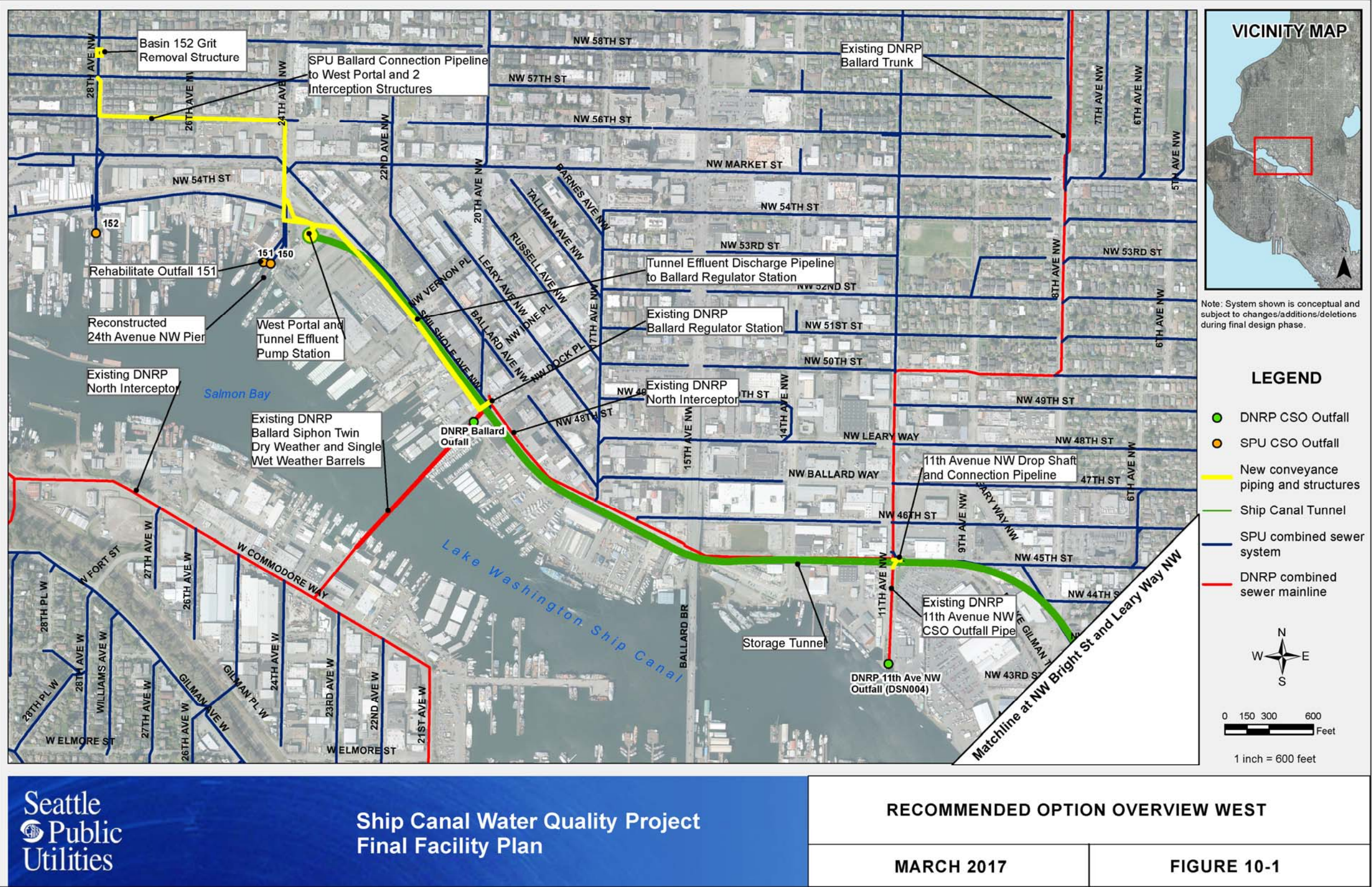
each end of the Storage Tunnel. The study area for archaeological cultural resources is the footprint of the tunnel portals, conveyance, and other near-surface impacts plus each adjacent parcel. The study area also includes the conceptual locations of the drop shafts. The storage tunnel alignment is not included in the archaeological or aboveground study areas, because the proposed tunnel depth is within Pleistocene soils and, therefore, predates human occupation of the Puget Sound region.

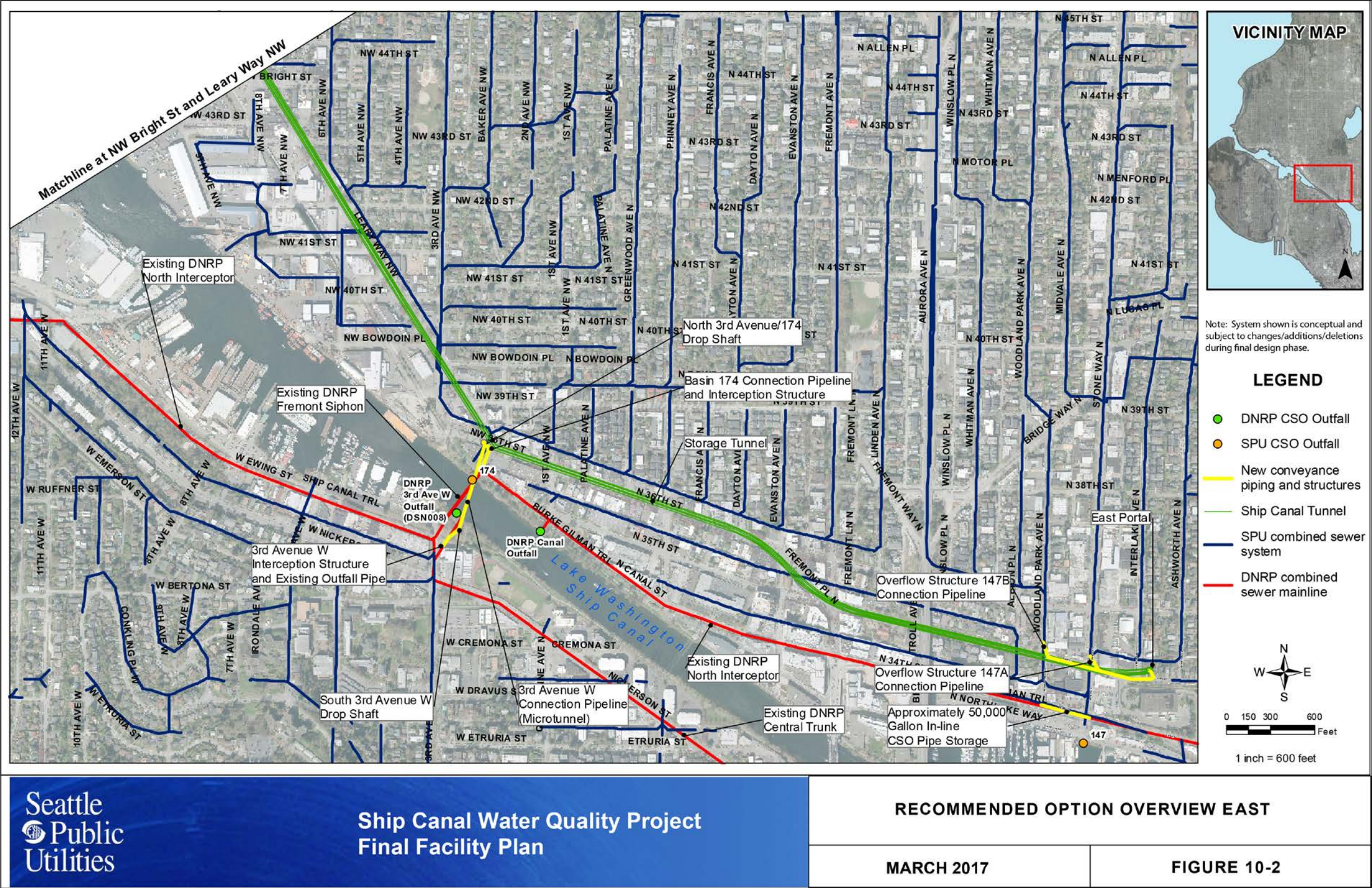
No archaeological sites are recorded within the study area; therefore, no construction impacts on archaeological resources are anticipated. Although no subsurface survey has been conducted in the study area, several DNRP wastewater facilities, including the Ballard Siphon, have been archaeologically monitored. No cultural resources were identified during monitoring activities (Lockwood and Hoyt, 2012). WISAARD includes a statewide predictive model for precontact archaeology; the archaeological study area is considered “high risk” and “very high risk” for buried cultural resources. Buried cultural resources could include precontact sites, such as Native American encampments, resource procurement sites, food processing sites, or historic buried resources, including foundations and historic abandoned infrastructure, privies, and dumps. These might be present as deep as 25 feet below the present-day ground surface. A review of geological maps suggests that the tunnel itself would not intersect cultural deposits because it will be constructed within pre-Holocene soils.

If archaeological resources were identified during construction, potential impacts to archaeological resources would be permanent because the resources are assumed to be displaced from their context during construction. Near-surface ground disturbance that affects Holocene-aged sediments and historical fill deposits has the potential to affect archaeological resources.

No archaeological sites have been recorded within the study area; however, no surveys have been conducted. Archaeological monitoring is recommended for excavation in intact Holocene strata.

Operational impacts to historic resources might include permanent visual impacts or operational odor, noise, or vibration. Based on preliminary design information, no significant probable operational impacts are expected to aboveground historic resources. No operational impacts to archaeological resources are expected.

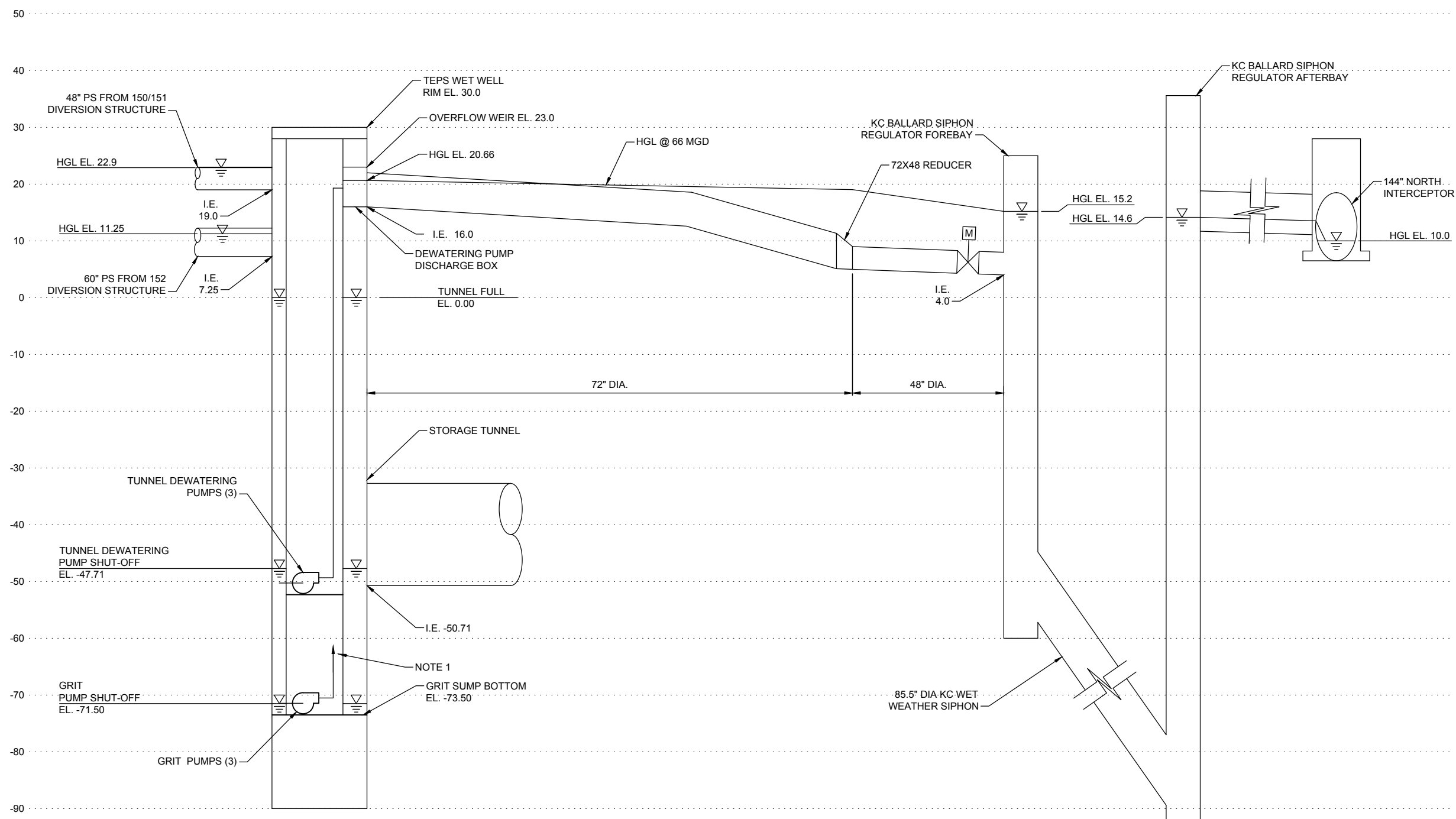






FACILITY PLAN - NOT FOR CONSTRUCTION

C:\pw_workdir\den001\dkendall\d0506076\FIGURE 10-3.dwg
dkendall Feb-14-17 9:57am



DATE

MARK

NATURE

MADE

CHKD

REVD

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

100

101

102

103

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

119

120

121

122

123

124

125

126

127

128

129

130

131

132

133

134

135

136

137

138

139

140

141

142

143

144

145

146

147

148

149

150

151

152

153

154

155

156

157

158

159

160

161

162

163

164

165

166

167

168

169

170

171

172

173

174

175

176

177

178

179

180

181

182

183

184

185

186

187

188

189

190

191

192

193

194

195

196

197

198

199

200

201

202

203

204

205

206

207

208

209

210

211

212

213

214

215

216

217

218

219

220

221

222

223

224

225

226

227

228

229

230

231

232

233

234

235

236

237

238

239

240

241

242

243

244

245

246

247

248

249

250

251

252

253

254

255

256

257

258

259

260

261

262

263

264

265

266

267

268

269

270

271

272

273

274

275

276

277

278

279

280

281

282

283

284

285

286

287

288

289

290

291

292

293

294

295

296

297

298

299

300

301

302

303

304

305

306

307

308

309

310

311

312

313

314

315

316

317

318

319

320

321

322

323

324

325

326

327

328

329

330

331

332

333

334

335

336

337

338

339

340

341

342

343

344

345

346

347

348

349

350

351

352

353

354

355

356

357

358

359

360

361

362

363

364

365

366

367

368

369

370

371

372

373

374

375

376

377

378

379

380

381

382

383

384

385

386

387

388

389

390

391

392

393

394

395

396

397

398

399

400

401

402

403

404

405

406

407

408

409

410

411

412

413

414

415

416

417

418

419

420

421

422

423

424

425

426

427

428

429

430

431

432

433

434

435

436

437

438

439

440

441

442

443

444

445

446

447

448

449

450

451

452

453

454

455

456

457

458

459

460

461

462

463

464

465

466

467

468

469

470

471

472

473

474

475

476

477

478

479

480

481

482

483

484

485

486

487

488

489

490

491

492

493

494

495

496

497

498

499

500

501

502

503

504

505

506

507

508

509

510

511

512

513

514

515

516

517

518

519

520

521

522

523

524

525

526

527

528

529

530

531

532

533

534

535

536

537

538

539

540

541

542

543

544

545

546

547

548

549

550

551

552

553

554

555

556

557

558

559

560

561

562

563

564

565

566

567

568

569

570

571

572

573

574

575

576

577

578

579

580

581

582

583

584

585

586

587

588

589

590

591

592

593

594

595

596

597

598

599

600

601

602

603

604

605

606

607

608

609

610

611

612

613

614

615

616

617

618

619

620

621

622

623

624

625

626

627

628

629

630

631

632

633

634

635

636

637

638

639

640

641

642

643

644

645

646

647

648

649

650

651

652

653

654

655

656

657

658

659

660

661

662

663

664

665

666

667

668

669

670

671

672

673

674

675

676

677

678

679

680

681

682

683

684

685

686

687

688

689

690

691

692

693

694

695

696

697

698

699

700

701

702

703

704

705

706

707

708

709

710

711

712

713

714

715

716

717

718

719

720

721

722

723

724

725

726

727

728

729

730

731

732

733

734

735

736

737

738

739

740

741

742

743

744

745

746

747

748

749

750

751

752

753

754

755

756

757

758

759

760

761

762

763

764

765

766

767

768

769

770

771

772

773

774

775

776

777

778

779

780

781

782

783

784

785

786

787

788

789

790

791

792

793

794

795

796

797

798

799

800

801

802

803

804

805

806

807

808

809

810

811

812

813

814

815

816

817

818

819

820

821

822

823

824

825

826

827

828

829

830

831

832

833

834

835

836

837

838

839

840

841

842

843

844

845

846

847

848

849

850

851

852

853

854

855

856

857

858

859

860

861

862

863

864

865

866

867

868

869

870

871

872

873

874

875

876

877

878

879

880

881

882

883

884

885

886

887

888

889

890

891

892

893

894

895

896

897

898

899

900

901

902

903

904

905

906

907

908

909

910

911

912

913

914

915

916

917

918

919

920

921

922

923

924

925

926

927

928

929

930

931

932

933

934

935

936

937

938

939

940

941

942

943

944

945

946

947

948

949

950

951

952

953

954

955

956

957

958

959

960

961

962

963

964

965

966

967

968

969

970

971

972

973

974

975

976

977

978

979

980

981

982

983

984

985

986

987

988

989

990

991

992

993

994

995

996

997

998

999

1000

1001

1002

1003

1004

1005

1006

1007

1008

1009

1010

1011

1012

1013

1014

1015

1016

1017

1018

1019

1020

1021

1022

1023

1024

1025

1026

1027

1028

1029

1030

1031

1032

1033

1034

1035

1036

1037

1038

1039

1040

1041

1042

1043

1044

1045

1046

1047

1048

1049

1050

1051

1052

1053

1054

1055

1056

1057

1058

1059

1060

1061

1062

1063

1064

1065

1066

1067

1068

1069

1070

1071

1072

1073

1074

1075

1076

1077

1078

1079

1080

1081

1082

1083

1084

1085

1086

1087

1088

1089

1090

1091

1092

1093

1094

1095

1096

1097

1098

1099

1100

1101

1102

1103

1104

1105

1106

1107

1108

1109

1110

1111

1112

1113

1114

1115

1116

1117

1118

1119

1120

1121

1122

1123

1124

1125

1126

1127

1128

1129

1130

1131

1132

1133

1134

1135

1136

1137

1138

1139

1140

1141

1142

1143

1144

1145

1146

1147

1148

1149

1150

1151

1152

1153

1154

1155

1156

1157

1158

1159

1160

1161

1162

1163

1164

1165

1166

1167

1168

1169

1170

1171

1172

1173

1174

1175

1176

1177

1178

1179

1180

1181

1182

1183

1184

1185

1186

1187

1188

1189

1190

1191

1192

1193

1194

1195

1196

1197

1198

1199

1200

1201

1202

1203

1204

1205

1206

1207

1208

1209

1210

1211

1212

1213

1214

1215

1216

1217

1218

1219

1220

1221

1222

1223

1224

1225

1226

1227

1228

1229

1230

1231

1232

1233

1234

1235

1236

1237

1238

1239

1240

1241

1242

1243

1244

1245

1246

1247

1248

1249

1250

1251

1252

1253

1254

1255

1256

1257

1258

1259

1260

1261

1262

1263

1264

1265

1266

1267

1268

1269

1270

1271

1272

1273

1274

1275

1276

1277

1278

1279

1280

1281

1282

1283

1284

1285

1286

1287

1288

1289

1290

1291

1292

1293

1294

1295

1296

1297

1298

1299

1300

1301

1302

1303

1304

1305

1306

1307

1308

1309

1310

1311

1312

1313

1314

1315

1316

1317

1318

1319

1320

1321

1322

1323

1324

1325

1326

1327

1328

1329

1330

1331

1332

1333

1334

1335

1336

1337

1338

1339

1340

1341

1342

1343

1344

1345

1346

1347

1348

1349

1350

1351

1352

1353

1354

1355

1356

1357

1358

1359

1360

1361

1362

1363

1364

1365

1366

1367

1368

1369

1370

1371

1372

1373

1374

1375

1376

1377

1378

1379

1380

1381

1382

1383

1384

1385

1386

1387

1388

1389

1390

1391

1392

1393

1394

1395

1396

1397

1398

1399

1400

1401

1402

1403

1404

1405

1406

1407

1408

1409

1410

1411

1412

1413

1414

1415

1416

1417

1418

1419

1420

1421

1422

1423

1424

1425

1426

1427

1428

1429

1430

1431

1432

1433

1434

1435

1436

1437

1438

1439

1440

1441

1442

1443

1444

1445

1446

1447

1448

1449

1450

1451

1452

1453

1454

1455

1456

1457

1458

1459

1460

1461

1462

1463

1464

1465

1466

1467

1468

1469

1470

1471

1472

1473

1474

1475

1476

1477

1478

1479

1480

1481

1482

1483

1484

1485

1486

1487

1488

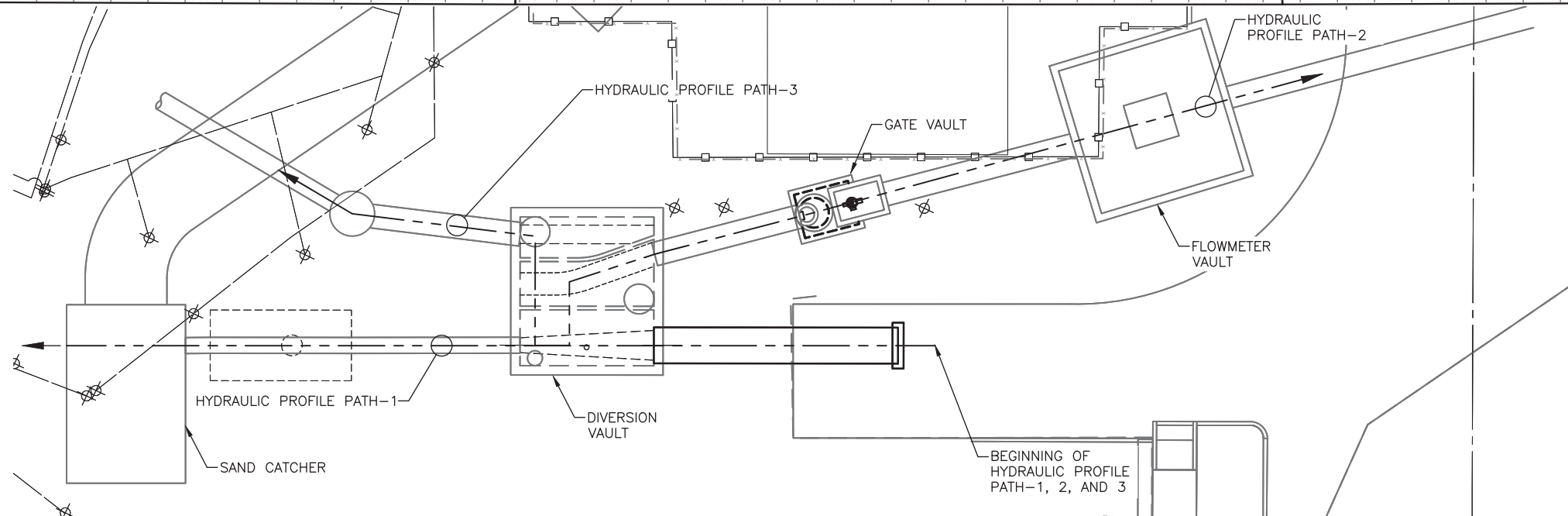
1489

1490

1491

14

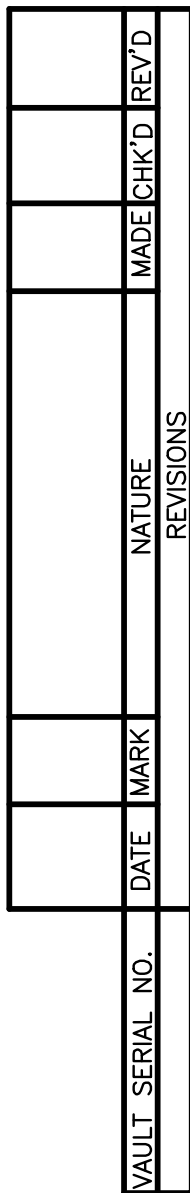
P:\Project\261-1065\05-design\drawings\B-Sheets\6 261-1065_P-HYDR-PROF.dwg
shadabs Feb-13-17 5:33pm



SCWQP: FREMONT
CONVEYANCE

A circular professional engineer seal for Patrick J. Murphy, State of Washington. The seal features a portrait of a man in the center, with the text "PATRICK J. MURPHY" at the top, "STATE OF WASHINGTON" around the top inner edge, "27456" below the portrait, "REGISTERED" below the number, and "PROFESSIONAL ENGINEER" around the bottom inner edge.

JOB NO.	PC	C315504
	R/W	
	CO	
VAULT PLAN NO. 777-905		
SHEET 6 OF 23		



1. HGL SHOWN IS THE MAXIMUM VALUE FOR THE 1990 TO 2009 SWMM MODEL SIMULATION DURING PERIODS OF ACTIVE FLOW DIVERSION TO THE TUNNEL. FOR DRY WEATHER CONDITIONS, THE DIVERSION PIPING CARRIES NO FLOW.
2. DIVERSION GATES TO BE LOCATED WITHIN EXISTING SEWER. GATES WILL CLOSE TO START DIVERSION TO TUNNEL. GATE OPERATION CONTROLS WILL NEED TO MONITOR AND RESPOND TO UPSTREAM SEWER FLOWS AND DOWNSTREAM WATER LEVELS IN COUNTY INTERCEPTOR.

FACILITY PLAN - NOT FOR CONSTRUCTION



REVIEWED BY SPU/WATER ENGINEERING	20.....
REVIEWED BY SPU/DRAINAGE	20.....
APPROVED BY SDOT STREET IMPROVEMENT PERMITTING	20.....

APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20

BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

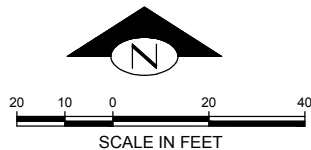
NAME OR INITIALS AND DATE		INITIALS AND DATE	
DESIGNED		REVIEWED:	
CHECKED C. HARRIS		DES.	CONST.
		SDOT	PROJ. MGR.
DRAWN		RECEIVED	
CHECKED			
		REVISED AS BUILT	
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS, AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.			



FIGURE 10-9
HYDRAULIC PROFILE
OUTFALL 147 CONNECTION PIPELINE

SHIP CANAL WATER
QUALITY PROJECT

JOB NO.	PC	C314056
	R/W	
	CO	C314056
VAULT PLAN NO.		
SHEET		OF



NOTES
UNLESS OTHERWISE NOTED

1. CONTRACTOR TO FIELD VERIFY AND LOCATE ALL UTILITIES PRIOR TO BEGINNING WORK AND NOTIFY ENGINEER OF ANY DISCREPANCIES. CONTACT UTILITIES UNDERGROUND LOCATION CENTER AT 1-800-424-555 OR 811.
2. WEST SHAFT AND TUNNEL CONSTRUCTION TO OCCUR PRIOR TO PUMP STATION CONSTRUCTION. LOCATION OF SHAFT AND EXISTING SITE FEATURES TO BE VERIFIED AFTER COMPLETION OF WEST SHAFT CONSTRUCTION AND PRIOR TO COMMENCEMENT OF PUMP STATION CONSTRUCTION.
3. APPROXIMATE SITE ADDRESS: 5425 SHILSHOLE AVE NW.
4. KING COUNTY PARCEL # 0467000417 AND #0467000431.
5. FIRE ACCESS FOR A 100-FT AERIAL 500# TIP TILLER TRUCK EMERGENCY VEHICLE HAS BEEN VERIFIED USING AUTOTURN.

LEGAL DESCRIPTION:

1. PARCEL #0467000417 (NORTHERNMOST PARCEL): BALLARD TIDE LANDS PCL Y SEATTLE BLA #3011659 REC #20140108900001 SD BLA BEING POR BLOCK 8 OF SD ADD TGW UNPL PROP ADJ
2. PARCEL #0467000431 (MIDDLE PARCEL): BALLARD TIDE LANDS PCL Z SEATTLE BLA #3011659 REC #20140108900001 SD BLA BEING POR BLOCK 8 OF SD ADD TGW UNPL PROP ADJ
3. PARCEL #0467000423 (YANKEE DINER): BALLARD TIDE LANDS THAT POR LOTS 1-2-3 BLK 8 DAF BEG MOST WLY COR SD BLK 8 TH N 32-22-11 E ALG NWLY LN THOF 135.67 FT TO THE TPOB TH S 42-21-43 E 149.69 FT TH N 48-05-37 E 148.07 FT TH N 41-54-23 W 18.44 FT TH N 48-05-37 E 50 FT M/L TO GOVT MDR LN TH NWLY ALG SD GOVT MDR LN TO SE LN OF 24TH AV NW TH SWLY ALG SD SE LN TO THE POB

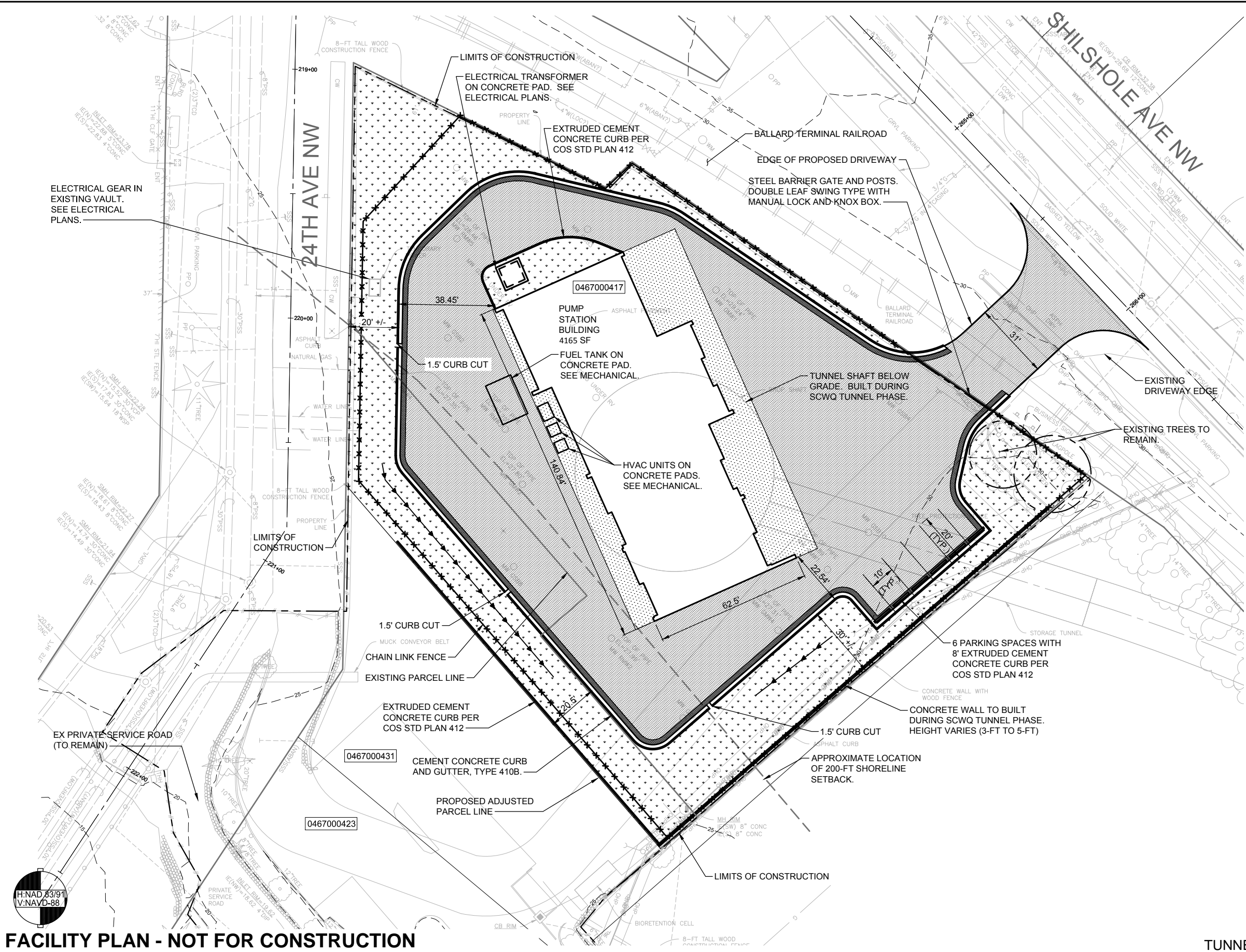
NOTES TO REVIEWER:

1. LIMITS OF STREET RESTORATION WITHIN RIGHT OF WAY WILL BE INCLUDED IN CONSTRUCTION DOCUMENT SET AT 60% SUBMITTAL.

SITE LEGEND:

##	PROPERTY NUMBER
---	LIMITS OF CONSTRUCTION
*****	CHAIN LINK FENCE
[Pattern: Solid Grey]	PROPOSED FULL DEPTH ASPHALT PAVEMENT
[Pattern: Dotted Grey]	PROPOSED 3" ASPHALT OVERLAY
[Pattern: Stippled Grey]	6" CONCRETE PAVEMENT
[Pattern: Dotted White]	LANDSCAPE AREA SEE LANDSCAPE PLANS

FIGURE 10-10
TUNNEL EFFLUENT PUMP STATION - FINISHED SITE PLAN



FACILITY PLAN - NOT FOR CONSTRUCTION

 EES ENTITLEMENT & ENGINEERING SOLUTIONS, INC.	 McMILLEN JACOBS ASSOCIATES	APPROVED FOR ADVERTISING NANCY LOCKE DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES SEATTLE, WASHINGTON 20 BY: CITY PURCHASING & CONTRACTING SERVICES DIRECTOR	INITIALS AND DATE	INITIALS AND DATE		SHIP CANAL WATER QUALITY PROJECT	PC R/W CO
			DESIGNED AMP CHECKED	REVIEWED: DES. SDOT CONST. PROJ. MGR. RECEIVED REVISED AS BUILT			VAULT PLAN NO.
							SHEET C-130 OF 70

C:\Users\jacob.jacobson\OneDrive - cadddocuments\STEPS\CIVIL\20110813_P-C-130.dwg
File: jacobson.dwg Jan-03-16 10:43am

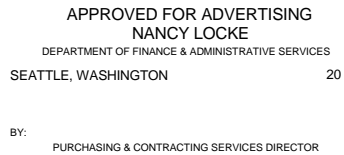


FIGURE 10-11
TUNNEL EFFLUENT PUMP STATION - 3D VIEWS

JOB NO. PC ---
R/W ---
CO ---

VAULT PLAN NO.

SHEET 62 OF 70



BY: PURCHASING & CONTRACTING SERVICES DIRECTOR

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL

FIGURE 10-12
TUNNEL EFFLUENT PUMP STATION - 3D VIEWS

JOB NO.	PC	---
	R/W	---
	CO	---

VAULT PLAN NO.

SHEET **63** OF **70**



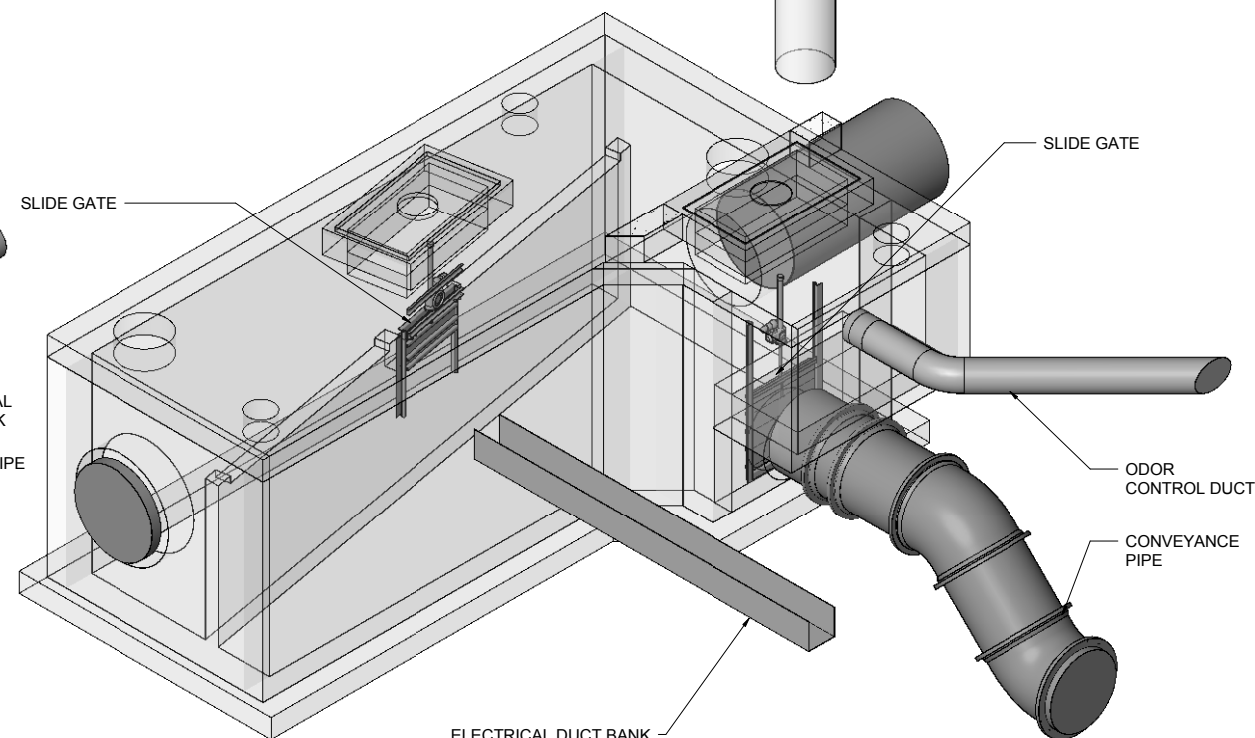
INITIALS AND DATE		INITIALS AND DATE	
DESIGNED Designer		REVIEWED: DES.	CONST.
CHECKED Checker		SDOT	PROJ. MGR.
DRAWN Author		RECEIVED	
CHECKED Checker		REVISED AS BUILT	
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-2.3 OF THE PROJECT MANUAL.			






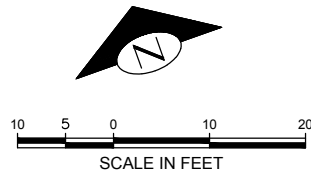
JOB NO.	PC	---
	R/W	---
	CO	---
VAULT PLAN NO.		
SHEET		OF



FIGURE 10-15
11TH AVE DROP SHAFT - 3D VIEWS

FIGURE 10-16
AFT - 3D VIEWS

 	<p>APPROVED FOR ADVERTISING NANCY LOCKE</p> <p>DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES</p> <p>SEATTLE, WASHINGTON 20</p>	<table border="1"> <tr> <th colspan="2">INITIALS AND DATE</th> <th colspan="2">INITIALS AND DATE</th> </tr> <tr> <td>DESIGNED Designer</td> <td></td> <td>REVIEWED:</td> <td></td> </tr> <tr> <td>CHECKED Checker</td> <td></td> <td>DES.</td> <td>CONST.</td> </tr> <tr> <td></td> <td></td> <td>SDOT</td> <td>PROJ. MGR.</td> </tr> <tr> <td colspan="2">DRAWN Author</td> <td colspan="2">RECEIVED</td> </tr> <tr> <td>CHECKED Checker</td> <td></td> <td colspan="2">REVISED AS BUILT</td> </tr> <tr> <td colspan="4"> <small>ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 9-02.3 OF THE PROJECT MANUAL.</small> </td> </tr> </table>	INITIALS AND DATE		INITIALS AND DATE		DESIGNED Designer		REVIEWED:		CHECKED Checker		DES.	CONST.			SDOT	PROJ. MGR.	DRAWN Author		RECEIVED		CHECKED Checker		REVISED AS BUILT		<small>ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 9-02.3 OF THE PROJECT MANUAL.</small>					<p>SHIP CANAL WATER QUALITY PROJECT</p>	<p>PC ---</p>
	INITIALS AND DATE		INITIALS AND DATE																														
	DESIGNED Designer		REVIEWED:																														
	CHECKED Checker		DES.	CONST.																													
		SDOT	PROJ. MGR.																														
DRAWN Author		RECEIVED																															
CHECKED Checker		REVISED AS BUILT																															
<small>ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 9-02.3 OF THE PROJECT MANUAL.</small>																																	
<p>BY:</p> <p>PURCHASING & CONTRACTING SERVICES DIRECTOR</p>	<p>JOB NO.</p> <p>R/W ---</p> <p>CO ---</p>																																
	<p>VAULT PLAN NO.</p>																																
	<p>SHEET OF</p>																																

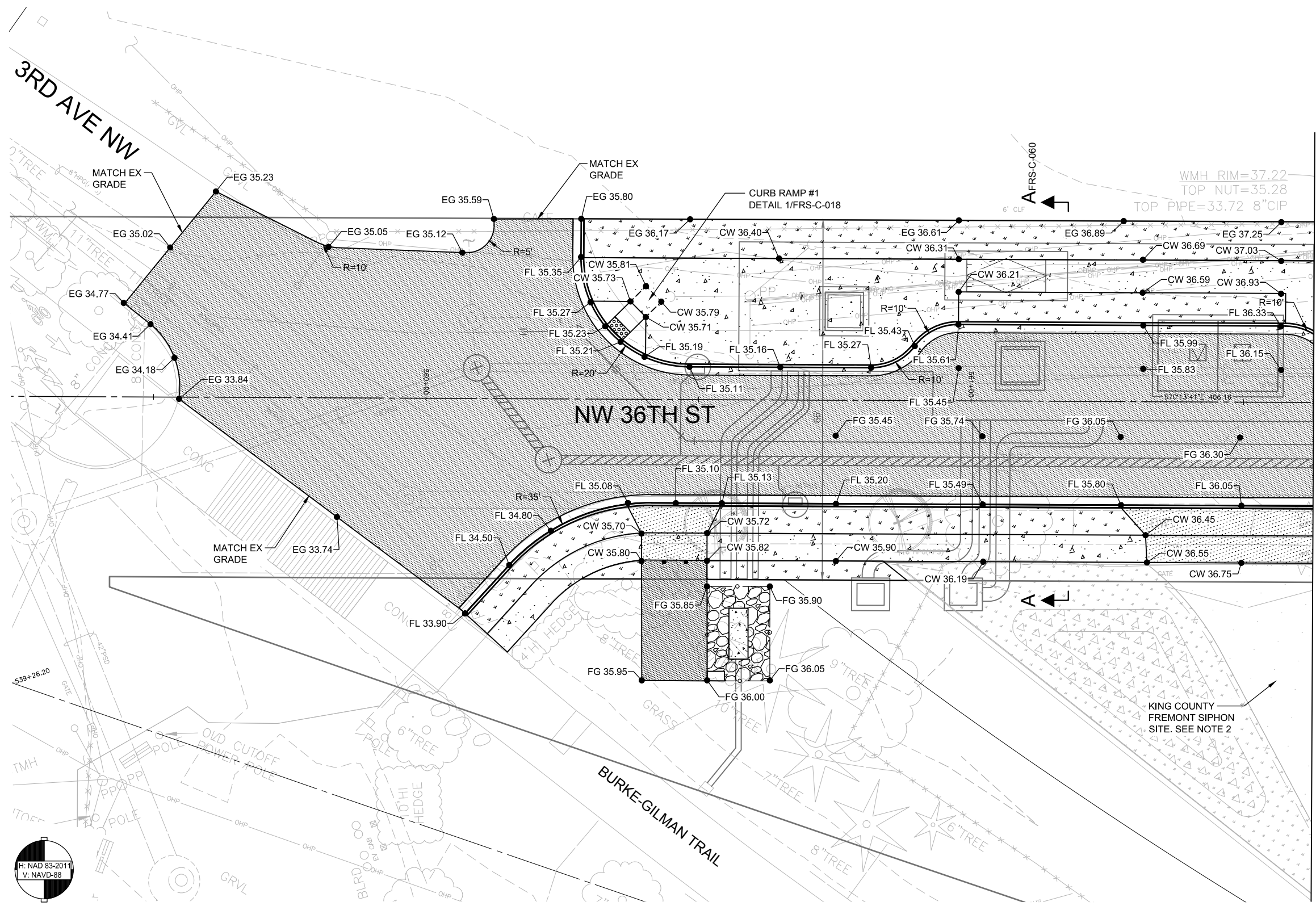


- NOTES:
1. VERIFY EX GR AT SITE LIMITS PRIOR TO FINAL SITE RESTORATION & NOTIFY ENGINEER OF ANY DISCREPENCIES.
 2. NOTE TO REVIEWER: KING COUNTY FREMONT SIPHON PROJECT CURRENTLY UNDER CONSTRUCTION. PROPOSED SITE DESIGN CURRENTLY SHOWN. FINAL AS-BUILTS TO BE SURVEYED AND UPDATED AS DESIGN PROGRESSES.
 3. LIMITS OF SITE RESTORATION/PHASING DEFINED WITHIN SPECIFICATIONS SECTION 01 11 00.
 4. FINAL GRADING SHOWN FOR THE ENTIRE PROJECT. CONTRACTOR TO PHASE RESTORATION BASED ON CONSTRUCTION LIMITS AS DEFINED WITHIN SPECIFICATIONS SECTION 01 11 00.

PAVING LEGEND:

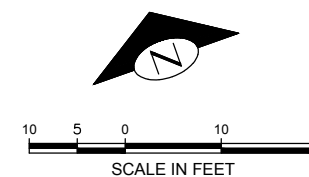
	TYPE [401_ OR 402_] ASPH PAVEMENT
	TYPE [401_ OR 402_] CONC PAVEMENT
	TYPE 410B CURB & GUTTER
	TYPE 410C CURB
	TYPE 420 SIDEWALK
	TYPE 430A DRIVEWAY

FIGURE 10-17
NORTH 3RD AVENUE / 174 - FINISHED SITE PLAN



FACILITY PLAN - NOT FOR CONSTRUCTION

 	APPROVED FOR ADVERTISING NANCY LOCKE DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES SEATTLE, WASHINGTON 20 BY: CITY PURCHASING & CONTRACTING SERVICES DIRECTOR	INITIALS AND DATE DESIGNED ES CHECKED JW, DS DRAWN ES CHECKED ED	INITIALS AND DATE REVIEWED: DES. SDOT CONST. PROJ. MGR. RECEIVED REVISED AS BUILT		SHIP CANAL WATER QUALITY PROJECT	PC JOB NO. R/W CO VAULT PLAN NO.
		ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.				SHEET OF 428



PAVING LEGEND:

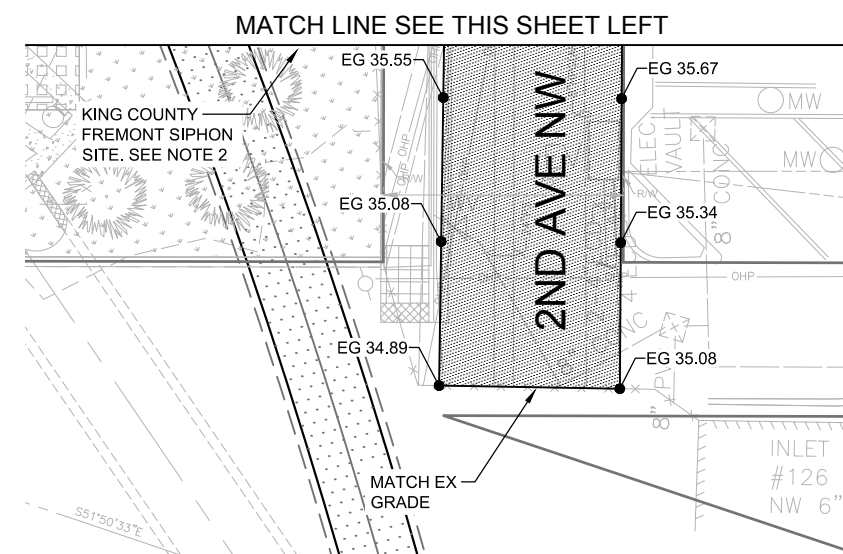


FIGURE 10-18
NORTH 3RD AVENUE / 174 - FINISHED SITE PLAN

FACILITY PLAN - NOT FOR CONSTRUCTION



APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20

BY: _____
CITY PURCHASING & CONTRACTING SERVICES DIRECTOR

INITIALS AND DATE

DESIGNED ES

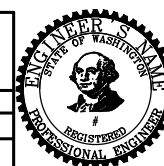
CHECKED JW, DS

DRAWN	ES
CHECKED	ED

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

INITIALS AND DATE	
REVIEWED:	
DES.	CONST.
SDOT	PROJ. MGR.

RECEIVED
REVISED AS BUILT

SHIP CANAL WATER QUALITY
PROJECT

JOB NO.	PC
	R/W
	CO

VAULT PLAN NO.	
SHEET	OF 428



BY: PURCHASING & CONTRACTING SERVICES DIRECTOR

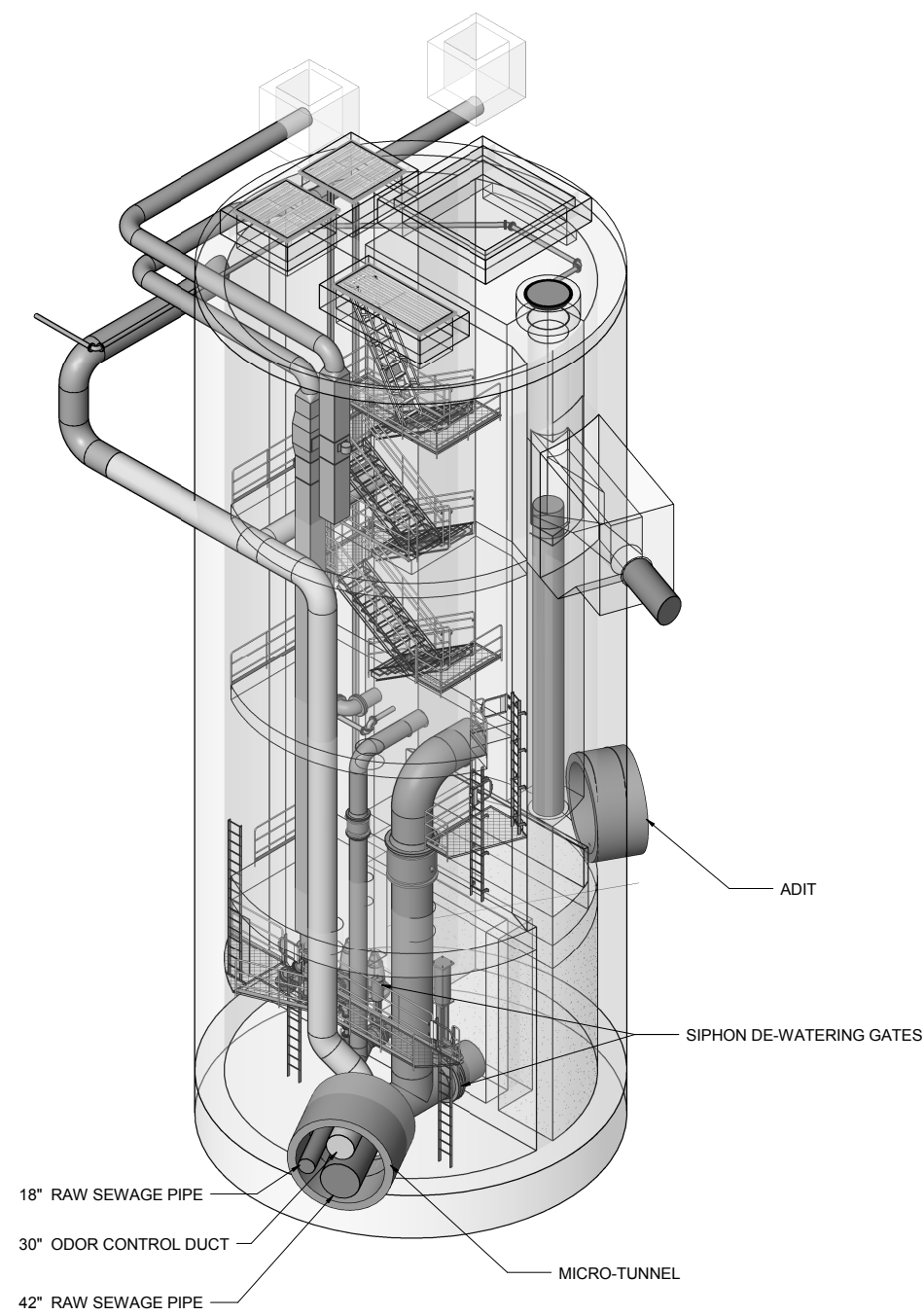
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

Y OF SEATTLE STANDARD PLANS AND
SECTION 0-02.3 OF THE PROJECT MANUAL.

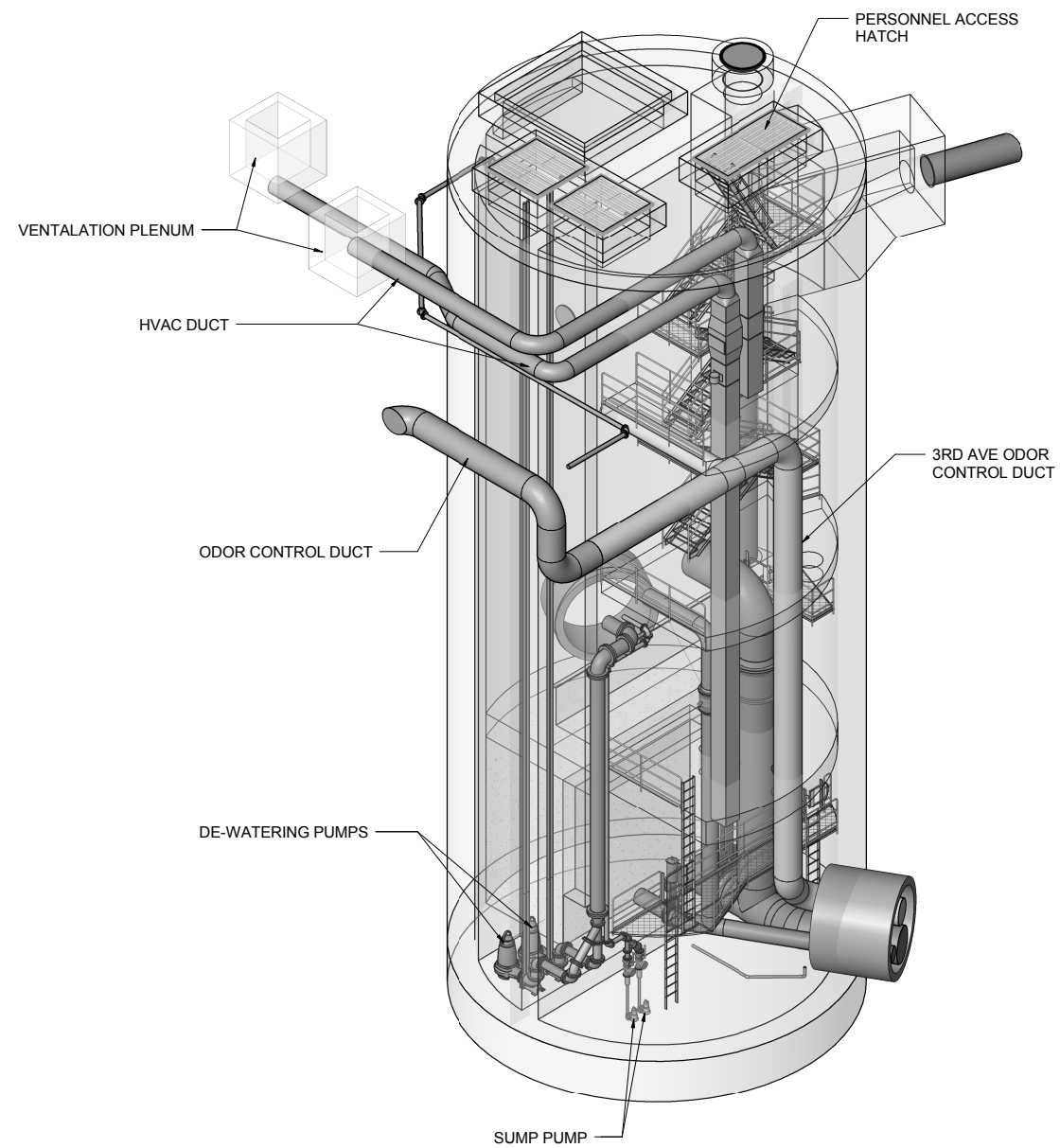


FIGURE 10-19
NORTH 3RD AVENUE / 174 - 3D VIEWS

Vault Serial No.	Date	Mark	Nature Revisions	Made Chkd REV'D



SHAFT - 3D VIEW 1
SCALE: NONE



SHAFT - 3D VIEW 2
SCALE: NONE

FIGURE 10-20
NORTH 3RD AVENUE / 174 - 3D VIEWS

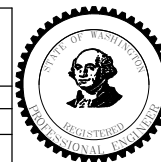


FACILITY PLAN - NOT FOR CONSTRUCTION



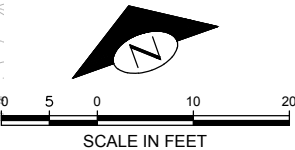
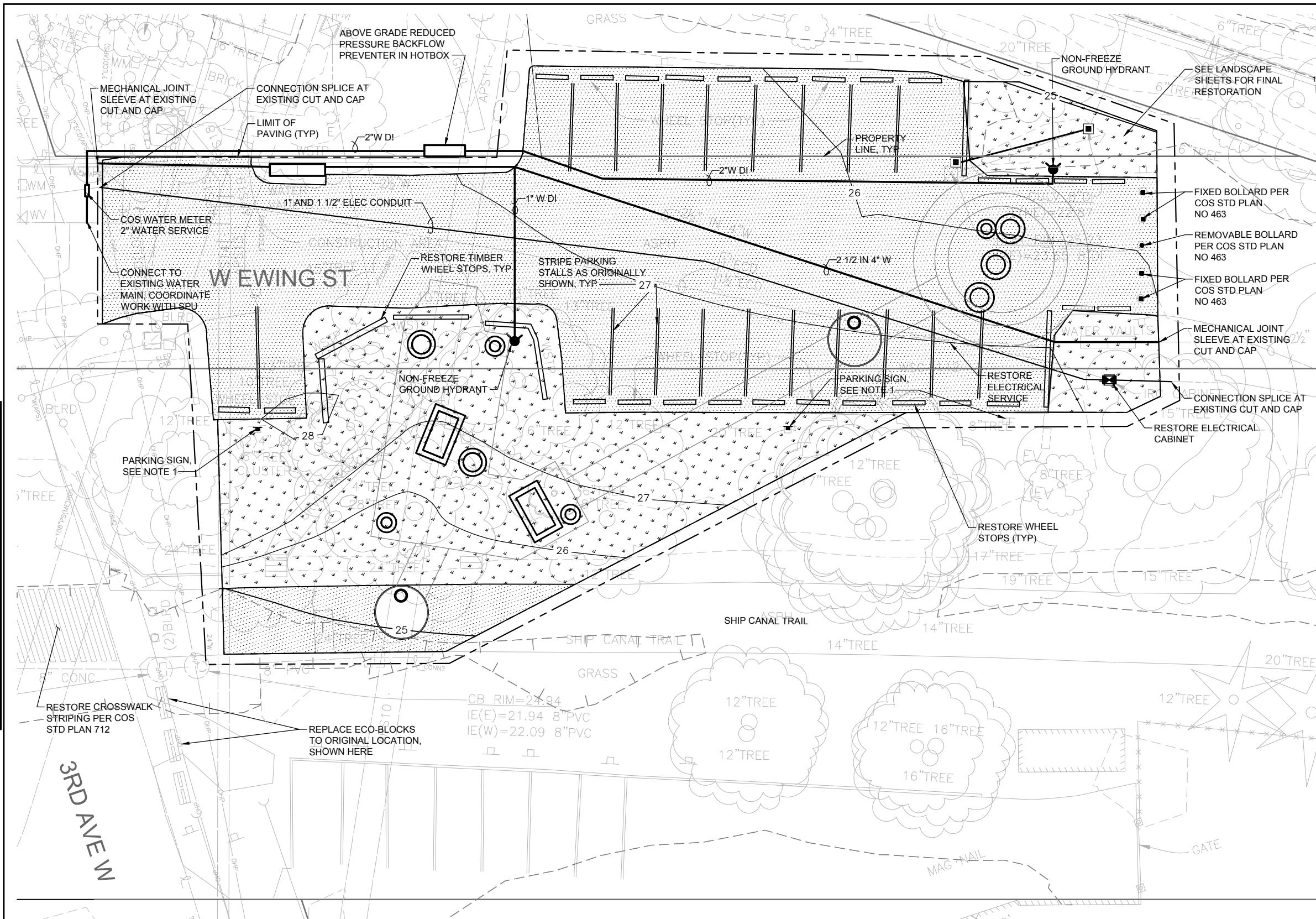
APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

INITIALS AND DATE		INITIALS AND DATE	
DESIGNED	Designer	REVIEWED:	
CHECKED	Checker	DES.	CONST.
		SDOT	PROJ. MGR.
DRAWN	Author	RECEIVED	
CHECKED	Checker	REVISED AS BUILT	
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 9-02.3 OF THE PROJECT MANUAL.			



SHIP CANAL WATER QUALITY
PROJECT

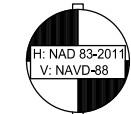
JOB NO.	PC ---
	R/W ---
	CO ---
VAULT PLAN NO.	
SHEET	OF



- NOTES:**
1. PARKING SIGNAGE TO BE COORDINATED WITH SDOT AND SEATTLE PARKS DEPARTMENT PRIOR TO FINAL DESIGN.
 2. CONTRACTOR TO FIELD VERIFY AND LOCATE ALL UTILITIES PRIOR TO BEGINNING WORK AND NOTIFY ENGINEER OF ANY DISCREPANCIES.
 3. RESTORE AND RE-OPEN THE SHIP CANAL TRAIL BEFORE COMPLETING OTHER SITE RESTORATION, SEE 3RS-C-010
 4. FOR LANDSCAPE PLANS SEE 3RS-L-002.
 5. FOR STORM DRAINAGE PLAN SEE 3RS-C-016.
 6. SEE 3RD AVE SHAFT SITE -STRUCTURAL FOR ADDITIONAL INFORMATION.
 7. SECANT PILE WALL AROUND SHAFT TO BE CUT OFF BELOW GRADE TO ALLOW UTILITIES SPACE TO ROUTE OVER.

PAVING LEGEND:

	TYPE 402C ASPH PAVEMENT, 6" THICKNESS
	LANDSCAPE RESTORATION AREA



FACILITY PLAN - NOT FOR CONSTRUCTION

**FIGURE 10-21
SOUTH 3RD AVENUE DROP SHAFT - FINISHED SITE PLAN**



APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20

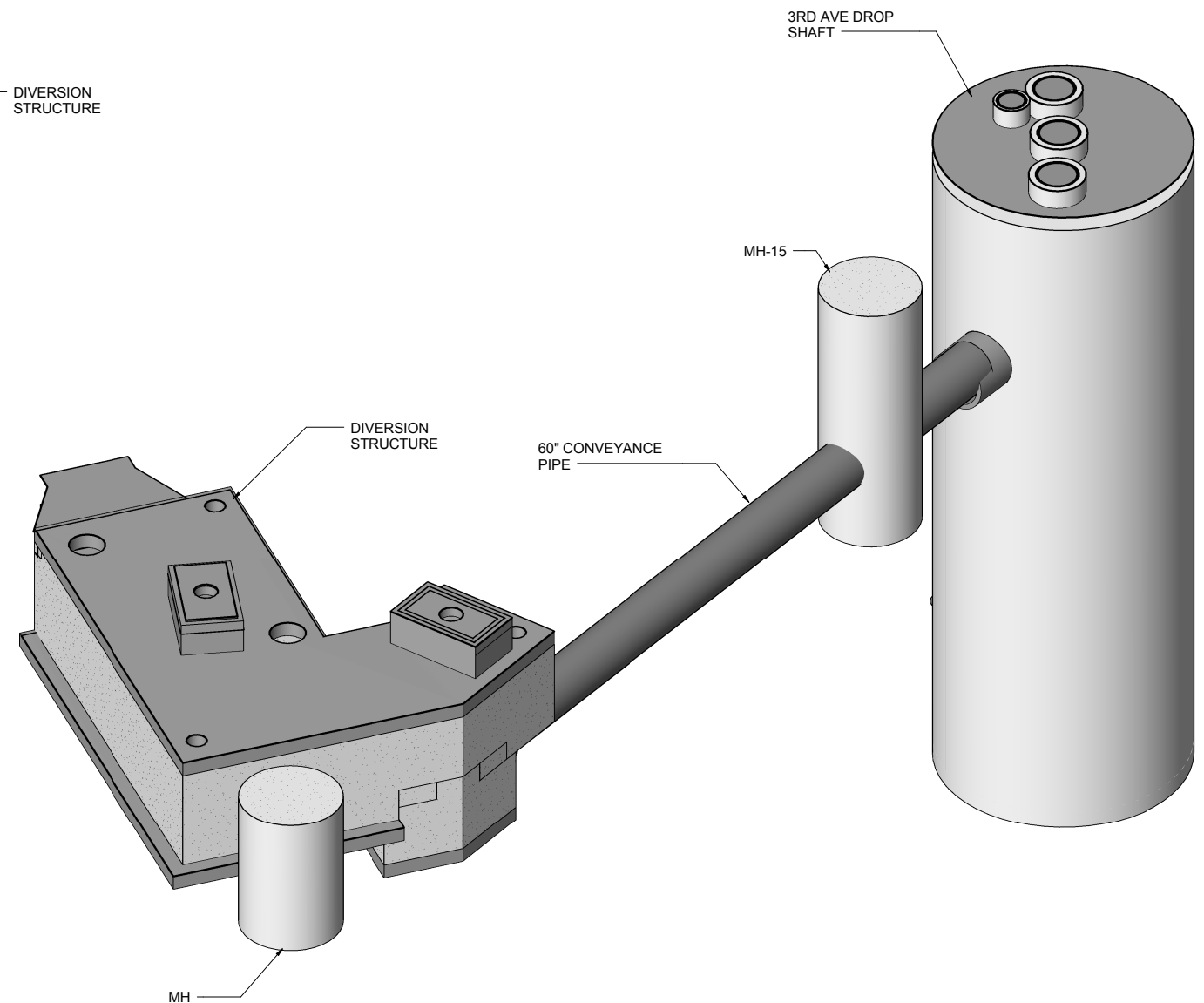
BY: CITY PURCHASING & CONTRACTING SERVICES DIRECTOR

INITIALS AND DATE		INITIALS AND DATE	
DESIGNED	SCM	REVIEWED:	
CHECKED	JJJ	DES.	CONST.
		SDOT	PROJ. MGR.
DRAWN	JMM	RECEIVED	
CHECKED	JJJ	REVISED AS BUILT	
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.			



**SHIP CANAL WATER QUALITY
PROJECT**

PC	R/W	CO
VAULT PLAN NO.		
SHEET	OF 428	



YARD PIPING - 3D VIEW 2

FIGURE 10-22
SOUTH 3RD AVENUE DROP SHAFT - 3-D VIEWS



McMILLEN
JACOBS
ASSOCIATES

BY: PURCHASING & CONTRACTING SERVICES DIRECTOR

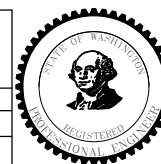
ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL

STATE OF WASHINGTON
REGISTERED
PROFESSIONAL ENGINEER

SHEET OF

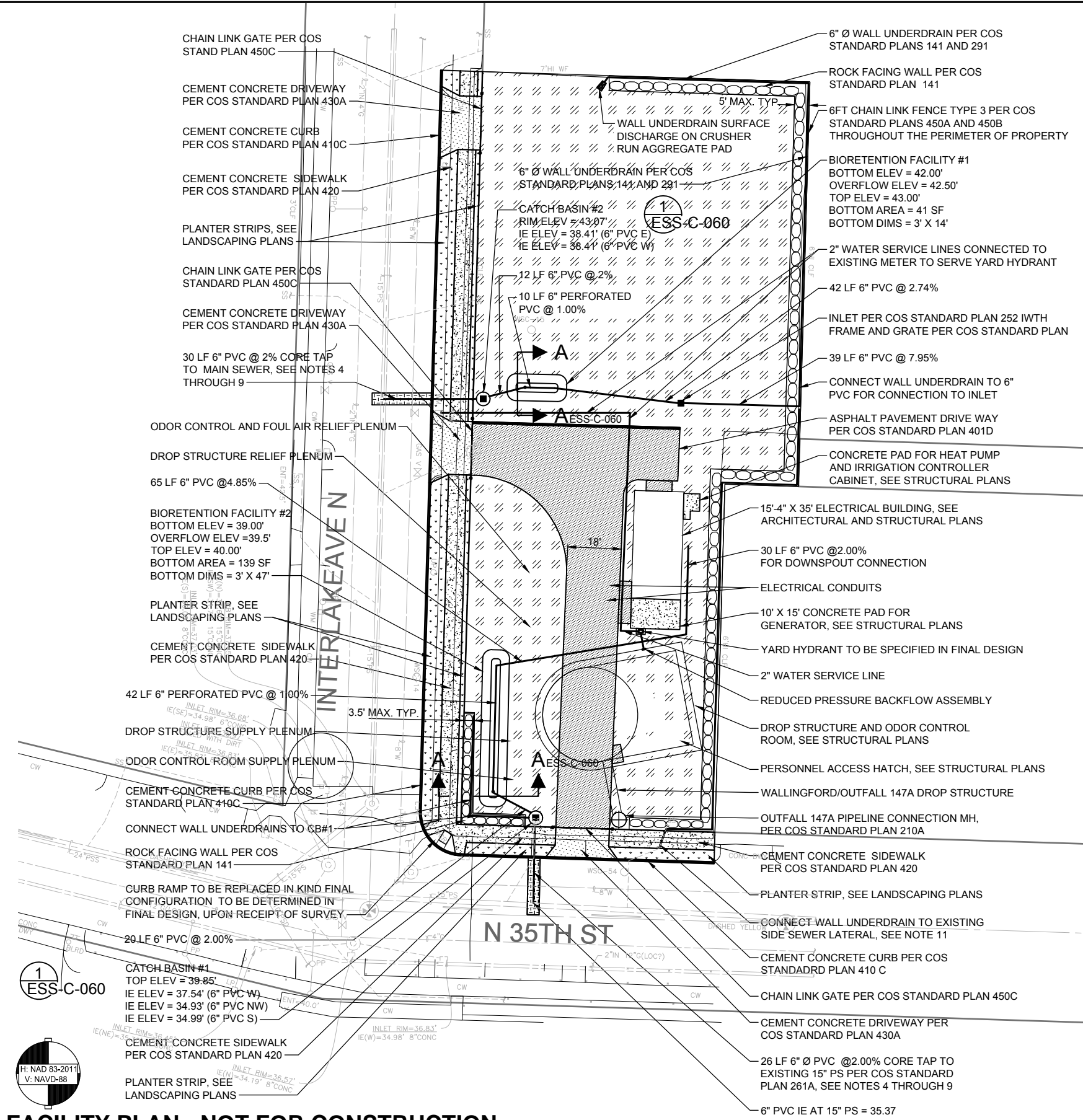


FIGURE 10-23
SOUTH 3RD AVENUE DROP SHAFT - 3D VIEWS



C:\Users\jacob.jacobs\Documents\cadd\DOCUMENT\CD\STUNNEL\LEAST SHATT SITE\CD\1261-1064_P-ESS-C-020.dwg
Pete Jacobschak Oct-19-16 1:32pm

VAULT SERIAL NO.	DATE	MARK	NATURE	REVISIONS	MADE	CHKD	REVD



NOTES:

1. CONTRACTOR TO FIELD VERIFY AND LOCATE ALL UTILITIES PRIOR TO BEGINNING WORK AND NOTIFY ENGINEER OF ANY DISCREPANCIES.
2. POTENTIAL UTILITY CONFLICTS TO BE INVESTIGATED FURTHER IN FINAL DESIGN.
3. LIMITS OF SITE RESTORATION TO BE DETERMINED IN FINAL DESIGN.
4. ALL PIPE CONNECTIONS TO PUBLIC SEWER MAINS SHALL BE IN COMPLIANCE WITH SEATTLE MUNICIPAL CODE 21.6 AND IN ACCORDANCE WITH COS STANDARD PLAN NO. 261.
5. ALL PAVEMENT OPENINGS ON RIGHT-OF-WAY SHALL BE IN ACCORDANCE WITH COS STANDARD PLAN NO 404C AND COS STANDARD SPECIFICATIONS 2-02 AND 2-04.
6. PIPE TRENCH SECTIONS SHALL BE IN ACCORDANCE WITH COS STANDARD PLAN NO. 284.
7. PIPE BEDDING SHALL BE IN ACCORDANCE WITH COS STANDARD PLAN NO. 285.
8. PAVEMENT PATCHING SHALL BE IN ACCORDANCE WITH COS STANDARD PLAN NO. 404A.
9. ROADWAY PAVEMENT CONCRETE REPAIRS SHALL BE IN ACCORDANCE WITH COS STANDARD PLAN NO. 405A AND 405B.
10. LOCATION OF CROSSWALK PAVEMENT MARKINGS WILL BE DETERMINED IN FINAL DESIGN, AFTER CURB RAMP SURVEY IS AVAILABLE.

PROPOSED SITE AND UTILITIES LEGEND:

	CEMENT CONCRETE SIDEWALK
	CONCRETE CURB
	CEMENT CONCRETE DRIVEWAY
	PLANTING STRIP
	ASPHALT PAVEMENT
	ASPHALT BERM
	ROCK FACING WALL
	CHAIN LINK GATE
	INLET
	SEWER MAINTENANCE HOLE
	CATCH BASIN
	STORM DRAIN PIPE
	WATER METER AND SERVICE LINE
	SOIL AMENDMENT, SEE LANDSCAPING PLANS
	ROAD SURFACE RESTORATION

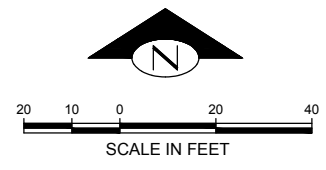
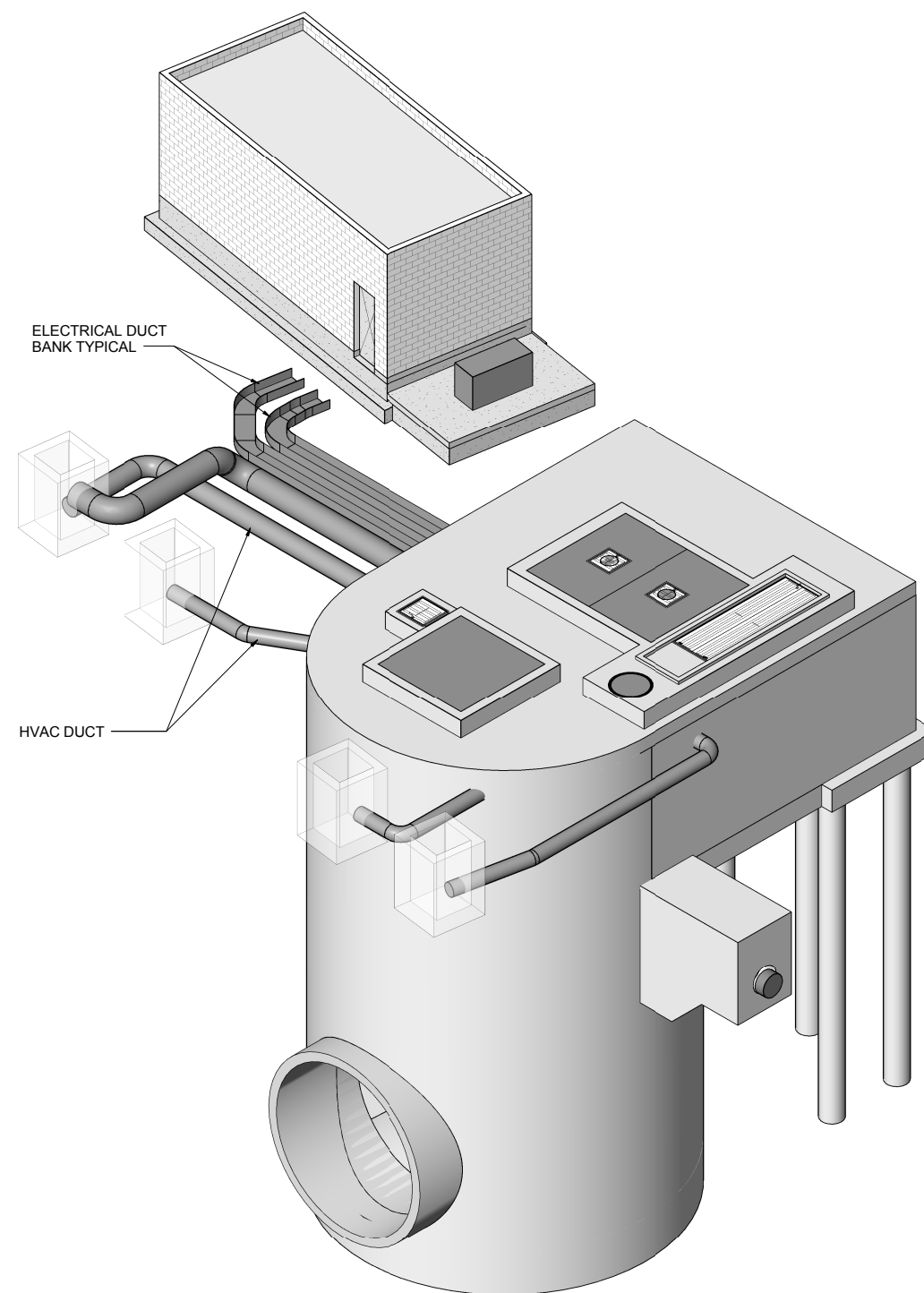


FIGURE 10-24
EAST PORTAL - FINISHED SITE PLAN

FACILITY PLAN - NOT FOR CONSTRUCTION

	APPROVED FOR ADVERTISING NANCY LOCKE DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES SEATTLE, WASHINGTON 20	INITIALS AND DATE DESIGNED: _____ CHECKED: _____ DRAWN: _____ CHECKED: _____	INITIALS AND DATE REVIEWED: DES. _____ CONST. _____ SDOT _____ PROJ. MGR. _____ RECEIVED _____ REVISED AS BUILT _____		SHIP CANAL WATER QUALITY PROJECT	PC JOB NO. _____ R/W CO _____ VAULT PLAN NO. _____
	BY: CITY PURCHASING & CONTRACTING SERVICES DIRECTOR	ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.	SHEET 395 OF 272			



YARD PIPING - 3D VIEW 2

FACILITY PLAN - NOT FOR CONSTRUCTION



**McMILLEN
JACOBS**
ASSOCIATES

JOB NO.	PC ---
	R/W ---
	CO ---
VAULT PLAN NO.	
SHEET	OF

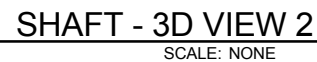
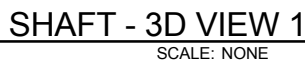


FIGURE 10-26
EAST PORTAL - 3D VIEWS

FACILITY PLAN - NOT FOR CONSTRUCTION



McMILLEN
JACOBS
ASSOCIATES

APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON

BY: PURCHASING & CONTRACTING SERVICES DIRECTOR

INITIALS AND DATE

DESIGNED Designer
CHECKED Checker

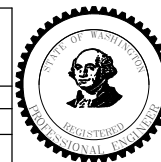
DRAWN Author
CHECKED Checker

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

INITIALS AND DATE

REVIEWED:	
DES.	CONST.
SDOT	PROJ. MGR.

RECEIVED
REVISED AS BUILT

SHIP CANAL WATER QUALITY
PROJECT

	PC	---
--	----	-----

JOB NO	RW	--
	CO	--

9	
VAULT PLAN NO.	

SHEET	OF
-------	----

11 Financial Analysis

This chapter includes financial information related to the recommended option for the Ship Canal WQ Project. The various components of project costs are described, including construction, non-construction, O&M, and total costs. This chapter also describes how capital projects are financed by SPU and King County and describes SPU's managerial capability.

11.1 Cost Estimates

This section describes the methodology and results for various components of project costs, including construction costs, total project costs, and O&M costs.

11.1.1 Background

Project cost estimates were prepared developed in accordance with *SPU's Cost Estimating Guide* (SPU, 2012e) and use the classification system defined in the AACEI cost-estimating system to define the level of accuracy. The primary defining characteristic for each class of estimate is the status of various design components. The cost estimate presented in this Facility Plan is considered a Study, Feasibility, or Class 4 estimate as defined by the AACEI.

Typical accuracy ranges for Class 4 estimates are -15 percent to -30 percent on the low side, and +20 percent to +50 percent on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Portions of the project have been advanced to a more detailed level of design to aid in development of this Facility Plan. However, the Class 4 estimate better represents the intention of the estimate at the facility planning stage. Accuracy ranges could exceed those shown in unusual circumstances. The accuracy range for this estimate has been determined to be -20 percent to +30 percent and is based on material, equipment, and labor pricing as of August 2014.

As discussed in Chapter 9, this Facility Plan evaluated a range for tunnel sizes from a nominal 14-foot ID up to 18-foot ID. Cost estimates were only developed for a nominal 14-foot ID tunnel, and is considered the baseline for project costs. The actual final tunnel diameter will be determined during detailed design phases, and any revisions from the established baseline will be managed through the agreed-upon change management process identified in the JPA.

11.1.2 Total Project Cost Estimate

The total project cost estimate for the project consists of the total construction contract amount, plus soft costs and inflation. Soft costs comprise SPU and consultant labor for engineering, design, and construction management; property acquisition; and other costs. Soft costs were determined by using 40 percent of construction contract amount per guidance from SPU, consistent with the percentage applied in earlier project phases.

Property acquisition costs, including full property purchases and temporary and permanent easements, are included in the project cost. All purchased property likely will not be required after the facility has been constructed. Excess property will be repurposed, and a property surplus credit of \$11 million is included in the Facility Plan cost estimate.

Contingency reserves were applied to the base costs (construction plus soft costs and property acquisition) based on the SPU *Cost Estimating Guide* and the project's complexity. A contingency reserve of 15 percent and management reserve of 10 percent was applied to determine the total project cost estimate. Total project costs also include commissioning and stabilization costs at the agreed-upon amount of \$9.4 million between SPU and DNRP (per approved JPA).

To ensure cost estimates reflect the estimated project cost at the time it is constructed, total costs were inflated to the predicted year of expenditure based on the schedule provided in Appendix A. The inflated sum of the total construction contract amount, soft costs, property acquisition, reserves, and commissioning and stabilization costs equals the total cost projection. Total cost projection for the Ship Canal WQ Project using a baseline 14-foot ID tunnel is presented in Table 11-1. Total project capital costs for the Ship Canal Water Quality WQ Project are estimated at \$423.4 million. As noted in Section 11.1.1, the estimate is AACEI Class 4, which has a level of accuracy of -20 percent, +30 percent (\$338.7 to \$550.4 million cost range).

The Facility Plan total cost projection will be updated as the design progresses. Updates will also reflect changes in financial considerations, including but not limited to escalation, inflation, sales tax, and accounting rules.

**Table 11-1. Estimated Total Cost Projection for the Ship Canal Water Quality Project:
14-Foot-Diameter Tunnel Basis**

Component	Cost ^a
Construction Bid Amount	\$191,300,000
Sales Tax (9.5 percent)	\$18,200,000
Total Construction Cost Amount	\$209,500,000
Soft Costs, Property, and Initiatives	\$105,000,000
Management Reserve and Contingency	\$62,500,000
Total Non-Construction Costs	\$167,500,000
Revenue (property surplus)	\$(11,000,000)
<u>Total Project Costs</u>	<u>\$366,000,000</u>
Stabilization and Commissioning	\$9,400,000
Inflation ^a	\$48,000,000
<u>Total Project Costs with Inflation</u>	<u>\$423,400,000</u>

^a Inflation is 2 percent inflation per year based on year of expenditure.

11.1.3 Operations and Maintenance Cost Estimates

The estimate for O&M and replacement costs is based on historical cost information and estimated O&M costs for the tunnel and TEPS from SPU's O&M staff. Table 11-2 shows the annual O&M costs estimated for the project. O&M and replacement costs are based on a 14-foot-ID tunnel.

Table 11-2. Annual Operation and Maintenance Costs, 14-Foot Diameter Tunnel Basis

Component	Average Annual O&M Cost	Source
TEPS and Tunnel Storage Annual O&M	\$733,500	SPU estimate based on current O&M practices; includes TEPS operation, odor control, generators, solids and grit handling
Conveyance System Annual O&M	\$120,600	SPU estimate based on current O&M practices; includes diversion structure sewer cleaning and upstream grit removal
Flow Monitoring Annual O&M	\$206,600	SPU estimate based on current O&M practices; includes varying number of meters used (9 during pre-construction, 27 during stabilization and 20 during post-construction). Cost presented in average annual over 100-year facility service life
Diversion Structures Annual O&M	\$15,000	SPU estimate based on current O&M practices
Total Annual O&M	\$1,075,700	

Present value O&M and replacement costs for a 100-year facility service life and a 5-, 10-, 25-, and 50-year equipment and structure service life were estimated. Five-year replacements include flow monitoring equipment and mechanical equipment replacement and repair, such as pump motor sensors and impellers. Ten-year replacements include major electrical equipment replacement and repair. Twenty-five-year replacements include major mechanical equipment replacement and repair. Fifty-year replacements include structural replacement and repair, such as rehabilitating concrete corrosion in structures. A discount rate of 3 percent was used. The replacement costs include hard and soft costs. Table 11-3 summarizes the present-value O&M and replacement costs for the recommended option.

Table 11-3. Present Value Operation and Maintenance and Replacement Costs for the Ship Canal Water Quality Project, 14-Foot-Diameter Tunnel Basis

Component	Cost	Comments
O&M Costs		
Total Annual O&M	\$1,075,700	Reference Table 11-2
100 Years Annual O&M	\$107,570,000	
Replacement Costs		
TEPS/Tunnel 5-Year Repair and Replacements	\$1,810,500	Replacement and repairs at 5-year intervals; includes 100% of minor mechanical, electrical, instrumentation, and control costs
TEPS/Tunnel 10-Year Repair and Replacements	\$14,000,000	Replacement and repairs at 10-year intervals; includes 100% of major electrical, instrumentation, and control costs
TEPS/Tunnel 25-Year Repair and Replacements	\$10,500,000	Replacement and repairs at 25-year intervals. Includes 100% of major mechanical costs.
TEPS/Tunnel 50-Year Repair and Replacements	\$11,000,000	Replacement and repairs at 50-year intervals. Includes 100% of structural concrete corrosion rehab costs
Conveyance System 10-Year Repair and Replacements	\$320,000	Replacement and repairs at 10-year intervals; includes 100% of major electrical, instrumentation, and control costs
Conveyance System 25-Year Repair and Replacements	\$1,050,000	Replacement and repairs at 25-year intervals; includes 100% of major mechanical costs
Conveyance System 50-Year Repair and Replacements	\$5,575,000	Replacement and repairs at 50-year intervals; includes 100% of structural concrete corrosion rehabilitation costs
Flow Monitoring 5-Year Repair and Replacements	\$6,725,000	Replacement and repairs at 5-year intervals; includes 100% of flow meters replaced. Includes varying number of meters used (9 during pre-construction, and 20 during post-construction). Replacement cost per meter estimated at \$18,800.
Total 100-Year O&M and Replacement	\$137,830,500	
Present Value 100-Year O&M and Replacement	\$36,100,000	Uses a 3% discount rate

11.2 User Charges

The Ship Canal WQ Project is a joint project between the City of Seattle and King County per the JPA and the modified King County Consent Decree. Costs for the joint project will be shared per the JPA, and thus, discussion of user charges, wastewater rates, and capital financing planning is relevant to both agencies.

For SPU, capital projects are financed with a combination of bond proceeds, grants and reimbursements, and current revenues (wastewater and drainage rates). The wastewater rate consists of a system component, set to recover SPU expenses, and a treatment component, set to recover payments to DNRP and Southwest Suburban Sewer District, whose facilities treat the wastewater conveyed by SPU's system. For wastewater, SPU collects charges based on metered water usage via the SPU combined utility bill. For drainage, SPU charges fees to property owners based on property characteristics that contribute to stormwater runoff. All rate increases are formally approved by the Seattle City Council. Drainage and wastewater rates were last increased on January 1, 2017.

Based on Facility Plan cost estimates for the Ship Canal WQ Project, the projected cash flow for capital costs from 2014 through 2026 is approximately \$423.4 million. Based on the latest cost projections, the Ship Canal WQ Project represents approximately 17.1 percent of SPU's Drainage and Wastewater Capital Improvement Program (CIP) spending between 2016 and 2021.

The two main revenue sources for DNRP consist of revenues from the monthly sewer rate and those of the capacity charge. Combined, they account for approximately 95 percent of the operating revenues of the utility; the monthly sewer rate accounts for approximately 82 percent of the total operating revenue and the capacity charge approximately 13 percent. In June 2016, the King County Council confirmed a monthly sewer rate of \$44.22 and adopted a capacity charge of \$60.80, both of which commenced on January 1, 2017.

11.2.1 Combined System Cost Allocation

The source of stormwater runoff conveyed in combined sewer pipes varies geographically. In "combined areas" of Seattle, road inlets and roof drains direct stormwater to the combined sewer system. In areas with partially separated sewers, SPU disconnected road inlets from combined sewer pipes when it constructed separate storm drains to convey road runoff to reduce CSOs. In these areas, roof drains still connect into the combined sewer. Stormwater runoff conveyed in combined sewer pipes contributes to the SPU's and DNRP's CSO control and treatment costs.

Before 2008, the costs of the combined sewer system were recovered solely from wastewater rates. Combined system expenses included constructing and maintaining the combined system infrastructure (CSO structures, pump stations, and combined sewer pipes) and a portion of the costs in the DNRP sewage treatment rate to manage CSOs. Beginning in 2008, a percentage of the costs associated with the combined sewer system are recovered through drainage rates to recognize that a portion of these costs is associated with stormwater.

11.2.2 Wastewater Rates

For SPU's single-family residential customers, the billing methodology is structured so that customers are assessed sewer charges only for the water that enters the wastewater system and not for irrigation, car washing, and other outdoor water uses that do not enter the wastewater system. During the winter (November to April), sewer charges are applied to actual water usage. During the summer (May to October), sewer charges are applied to the lesser of average winter usage or actual water usage. Multifamily and commercial customers are charged based on actual water consumption throughout the year unless they install submeters to measure actual use of the wastewater system.

Each year, DNRP adopts a monthly charge for sewage disposal by June 30. DNRP sets the sewer rate at a level that provides the DNRP with money sufficient, together with other sources of revenue, to pay all costs of the sewer system, including debt service on all obligations and to satisfy DNRP's debt service coverage policies. The monthly sewer rate is applied to each single-family residence ("residential customers") and to a residential customer equivalent value of each 750 cubic feet of water consumption by all other customers such as multifamily, commercial, and industrial properties. Each agency served by DNRP's wastewater services is billed monthly an amount based upon the adopted sewer rate and the number of residential customers and residential customer equivalents reported by the agency.

The next largest single source of operating revenue is the capacity charge, which has been levied since 1990 on customers who establish new connections to the sewer system. By DNRP policy, combined sewer overflow projects are not financed with capacity charge revenues. DNRP allows the capacity charge to be prepaid on a discounted basis at the customer's option. To provide a more stable, long-term revenue stream, DNRP established provisions that allow the annual updating of the discount rate based on the 15-year mortgage and 10- and 20-year investment rates, with the discount rate being updated in December of each year. The resulting discount rate is 3.0 percent during 2015.

City ordinance allows SPU to pass DNRP's wastewater treatment charge rate increases onto customers, with Seattle City Council approval. DNRP, which treats virtually all of the Seattle's wastewater, increased wholesale rates in 2011, 2013, and 2015.

Table 11-4 shows SPU's historical and current wastewater rates.

Table 11-4. SPU Monthly Wastewater Rates							
	2012	2013	2014	2015	2016	2017	2018
Cost per 100 cubic feet ^a	\$10.68	\$11.65	\$11.75	\$11.84	\$12.27	\$12.93	\$13.08

^a 100 cubic feet equals 748 gallons. Most wastewater residential customers are billed every 2 months. Eligible low-income customers can receive a 50 percent credit.

11.2.3 Drainage Rates

The SPU charges drainage fees based on a property's estimated impact on the drainage system. In 2008, SPU implemented a new drainage rate designed to increase equity among drainage customers and between wastewater and drainage customers. Owners of single-family and duplex parcels of less than 10,000 square feet pay an annual flat fee based on the size of their property. Previously, all residential parcels paid the same fee regardless of size. Owners of all other properties, including owners of single-family residences and duplexes on parcels of 10,000 square feet or greater, are charged based on the percent of impervious surface and billable property size. Table 11-5 shows SPU's historical and current drainage rates.

When available, SPU will apply for grant dollars and low-cost loans. These will typically be from the Washington State Water Pollution Control Revolving Loan Fund (SRF) or Public Works Trust Fund. However, given the uncertainty regarding availability of grants and loans from these sources, no funds from these sources have been assumed in the rate impact analysis.

DNRP prepares a 6-year financial plan in connection with the review and adoption of the annual sewer and capacity charge rates by the King County Council. The plan is periodically revised during the year to reflect year-to-date actual results and revisions in forecasted items. DNRP's current 6-year forecast indicates that relatively modest rate increases will be needed to finance their CIP that includes current cost estimates for their CSO program, including the Ship Canal WQ Project.

Table 11-5. Annual Drainage Rates

Category	2012	2013	2014	2015	2016	2017	2018
Single-Family Residential ^a							
0 to 1,999 square feet	\$149.33	\$164.05	\$180.96	\$198.83	\$123.81	\$140.46	\$154.82
2,000 to 2,999 square feet	\$149.33	\$164.05	\$180.96	\$198.83	\$206.93	\$231.47	\$251.82
3,000 to 4,999 square feet	\$192.79	\$212.92	\$234.87	\$258.06	\$286.63	\$319.05	\$345.37
5,000 to 6,999 square feet	\$261.66	\$289.11	\$318.92	\$350.40	\$390.03	\$432.45	\$466.30
7,000 to 9,999 square feet	\$332.23	\$365.97	\$403.70	\$443.55	\$491.40	\$543.98	\$585.66
Commercial ^b							
Undeveloped (0 to 15% impervious)							
Regular	\$21.96	\$23.31	\$25.71	\$28.25	\$31.24	\$34.76	\$37.62
Low Impact	\$13.76	\$13.65	\$15.06	\$16.54	\$18.57	\$20.67	\$22.38
Light (16 to 35% impervious)							
Regular	\$32.98	\$36.05	\$39.76	\$43.69	\$48.52	\$53.54	\$57.45
Low Impact	\$26.14	\$28.35	\$31.27	\$34.36	\$38.31	\$42.26	\$45.34
Medium (36 to 65% impervious)							
Regular	\$47.76	\$52.35	\$57.75	\$63.45	\$70.67	\$77.60	\$82.86
Low Impact	\$38.35	\$42.11	\$46.45	\$51.04	\$57.21	\$62.86	\$67.19
High (66 to 85% impervious)	\$63.01	\$70.23	\$77.48	\$85.12	\$93.56	\$102.48	\$109.15
Very High (86 to 100% impervious)	\$74.49	\$83.08	\$91.65	\$100.69	\$112.38	\$122.94	\$130.75

^a Single-family residences under 10,000 square feet are charged a flat annual rate per parcel, based on parcel size. Prior to 2016, parcels less than 3,000 square feet were all billed under the same tier. Single-family residential parcels 10,000 square feet or greater are billed under the commercial rate structure.

^b Commercial rates are charged per 1,000 square feet.

11.2.4 Seattle Public Utilities Financial Policies

Drainage and wastewater rates are set in accordance with financial policies adopted by the Seattle City Council. The current parity bond debt service coverage requirement is 1.25 times the annual debt service; however, the Seattle City Council has adopted a higher coverage target of 1.8 times the annual debt service. SPU also has a financial policy target to fund a minimum of 25 percent of its CIP (based on a 4-year rolling average) through sources other than bond proceeds. Other adopted internal policy targets in effect since 2004 include generally positive net income, a minimum year-end cash balance equal to the average monthly wastewater treatment cost, and a debt/asset ratio of less than 70 percent. The SPU Drainage and Wastewater Fund has performed well in relation to its adopted policy targets. Between 2004 and 2016, the fund met or exceeded all targets with the exception of net income in 2004 and 2007. Noncash accounting accruals and expense adjustments were the primary drivers in not meeting net income targets in those years.

11.2.5 King County Department of Natural Resources and Parks Financial Policies

King County's DNRP CIP financing consists primarily of proceeds from long-term fixed-rate sewer revenue bond sales, short-term variable-rate borrowing, cash transfers from the operating fund, and sources of low-interest loan programs administered by the State of Washington, such as SRF loans and Public Works Trust Fund loans. DNRP's share of the capital costs of the Ship Canal WQ Project will be financed through the resources indicated above, in accordance with the financial policies of King County. The actual mix and cost of the financing used will reflect the current financial and economic environment, DNRP's financial position, and the suitability of the project for below-market interest rate instruments. DNRP's share of operation costs of the project will be funded through the operating revenues of the DNRP.

11.3 Implementation Plan and Schedule

The recommended option is currently in the facility-planning phase. Tunnel storage and pump station primary design will occur in 2016 through 2018. A project schedule has been developed to meet critical milestone deadlines summarized in the *Plan to Protect Seattle's Waterways*, Volume 2 (SPU, 2015a), which are enforceable deadlines under the terms of the City of Seattle Consent Decree and the modified King County Consent Decree. Critical milestone dates relevant to the Facility Plan are listed previously in Chapter 1, Table 1-2, and Chapter 3, Table 3-1. Appendix A includes the project implementation schedule demonstrating that these critical milestone dates can be achieved.

Table 11-6 shows the projected annual cash flow for the Ship Canal WQ Project based on the project schedule shown in Appendix A and developed to meet critical project

milestones. The schedule and cash flow were developed in December 2016 and are subject to change as the project schedule is updated. The dollars are escalated to the year in which the costs occur. For example, the amounts for 2017 are expressed in 2017 dollars while the amounts for 2018 are expressed in 2018 dollars. A 2-percent annual rate was used for the cost escalation. The dollars are based on the total cost projection presented in Table 11-1 (14-foot ID tunnel basis). The joint project between SPU and DNRP is based upon the executed JPA. The JPA addresses the design, construction, and O&M of a joint tunnel. A discussion of the cost share between the City and King County is provided in Section 12.2 in Chapter 12.

Table 11-6 Projected Annual Cash Flow for the Ship Canal Water Quality Project

Year	Annual Cash Flow ^a
Prior Years ^b	\$38,200,000
2017	\$10,000,000
2018	\$15,900,000
2019	\$24,800,000
2020	\$71,000,000
2021	\$101,600,000
2022	\$72,500,000
2023	\$47,300,000
2024	\$32,400,000
2025	\$9,700,000
TOTAL	\$423,400,000

^a The amounts in future years (i.e., 2017 and beyond) are adjusted for inflation

^b The amount from prior years is based on actual dollars spent.

12 Other Topics

This chapter discusses the relevance of various city, state, and federal environmental regulations to the Ship Canal WQ Project. City regulations discussed relate to construction permits. Relevant state regulations include SEPA and the GMA. Section 12.6 presents the permits and approvals anticipated for the Ship Canal WQ Project.

12.1 Water Quality Management Plan Conformance

SPU and DNRP have several planning documents that address water quality management related to the sewer system and CSOs. Those documents include the 2015 *Plan to Protect Seattle's Waterways* (SPU, 2015a). DNRP submitted the *Final Post-Construction Monitoring Plan for King County CSO Controls* in 2012, found in Appendix H of the 2012 CSO Control Plan Amendment (King County, 2012a). This PCMP documents DNRP's plan to demonstrate attainment of water and sediment quality standards. Additionally, in 2015, SPU submitted to EPA and Ecology the Final PCMP (SPU, 2015b), for approval, in accordance with the City's Consent Decree. The Final PCMP documents SPU's plan to measure the effectiveness of CSO controls and demonstrate attainment of water and sediment quality standards.

On August 26, 2015, the Final PCMP was approved subject to SPU submitting the following: (a) detailed QAPPs for review and approval and (b) following approval of the QAPPs, sediment data reports for each surrogate outfall. Outfalls 147, 174, and 152 are among the 14 surrogate outfalls that will be analyzed as part of implementing the Final PCMP. The RWSP was adopted by the King County Council in November 1998 via Ordinance 13680, and the CSO Control Plan Amendment was adopted in 2012.

Due to concerns raised by members of the public about the sequence and priority of CSO investments compared with other water quality investments, the King County Executive recommended conducting a water quality assessment and monitoring study to inform the next King County CSO control program update for the 2019 NPDES permit renewal.

12.2 Project Identified in a General Sewer Plan, Capital Improvement Plan, and Long-Term Control Plan

The Ship Canal WQ Project is included in both SPU's Drainage and Wastewater and DNRP's CIPs. This project is also included in SPU's LTCP (Volume 2 of the *Plan to Protect Seattle's Waterways*; SPU, 2015a). Both SPU and the DNRP prepare 6-year drainage and wastewater CIP spending plans each year. DNRP funding corresponds to

the allocations for the 3rd Avenue W and 11th Avenue NW projects per the King County LTCP. Based on current cost estimates for the Ship Canal WQ Project, the projected cash flow from 2013 through 2018 is approximately \$70 million.

SPU and DNRP will share costs for the project following methodology outlined in the JPA (City of Seattle and King County, 2016). SPU will pay 65 percent of all costs of the Ship Canal WQ Project. DNRP will pay to SPU 35 percent of all costs of the Ship Canal WQ Project. The cost share percentages only apply to the allocation of all non-excluded costs of the Ship Canal WQ Project. Some are components of the Ship Canal WQ Project are associated with SPU's CSO control solution in the Ballard and Wallingford basins that are being constructed by SPU and that, consistent with Technical Memorandum No. 4 (City of Seattle and King County, 2012) and the JPA, are to be funded in their entirety by SPU. No costs associated with these components shall be borne by DNRP. The project description for the recommended option in Chapter 10 provides more details about these excluded components.

Based on the current total cost projections presented herein and the agreed-upon cost share, the 65 percent cost share of the Ship Canal WQ Project represents between approximately 33 percent of SPU's Drainage and Wastewater CIP spending between 2016 and 2021. Based on the 2015-2016 adopted budget, DNRP's 35 percent cost share of the joint tunnel project ranges from 0.5 percent to 11 percent of total annual capital spending during the life of the project; an average of approximately 5 percent of total capital spending during the 2014 to 2025 period.

12.3 State Environmental Policy Act Compliance

The proposed Ship Canal WQ Project was described and evaluated in the *Plan to Protect Seattle's Waterways*, including the Final Plan EIS (SPU, 2014b); however, specific project locations were not identified in the plan, and additional details have been identified during facility planning. To address SEPA requirements, SPU considered whether to prepare an environmental checklist or whether to supplement the Final Plan EIS. SPU opted to supplement the Final Plan EIS with a project-specific Supplemental EIS (SEIS) for the following reasons:

- The project includes several new components that were not described in the Final Plan and Final Plan EIS, including an aboveground structure at the TEPS, additional specifics on elements shared with DNRP, and the use of barging and pier construction and rail transport to support construction.
- Preparing a SEIS would allow for public comment on the new and changed site-specific elements of the project, both during scoping and during the Draft SEIS comment period. Identifying concerns during scoping would allow SPU to address concerns earlier in the project development and design process. Potential impacts,

while largely construction related, may be of concern to adjacent residents, nearby businesses, and tribes. Identifying and addressing concerns as part of the Draft SEIS would help SPU refine the design, manage schedule risks associated with the environmental review process, and provide a solid foundation for subsequent permitting.

- The SEIS format provides flexibility to describe options for construction methods, routes, and other project details so that final decisions can be made during project design.

12.4 State Environmental Review Process Compliance

All projects that receive financial assistance from the SRF program must follow the State Environmental Review Process (SERP). SERP compliance helps to ensure that environmentally sound and cost-effective alternatives are selected and that the public has had an opportunity to learn about and comment on the potential environmental impacts of a proposal. The following elements must be included, and are summarized in this section: 1) SEPA documentation, 2) cost-effective analysis, and 3) public participation, 4) review and concurrence by Ecology. SPU is planning to apply for financial assistance for the Ship Canal WQ Project.

12.4.1 State Environmental Policy Act Documentation

SPU issued a Draft EIS for the *Plan to Protect Seattle's Waterways* on May 29, 2014 (SPU, 2014a). Comments on the Draft EIS and responses were included in the Final Plan EIS, which was issued on December 4, 2014 (SPU, 2014b). SPU issued the project-specific Draft SEIS on September 22, 2016 (SPU, 2016). A public hearing on the Draft SEIS was held on October 18, 2016. The Final SEIS was issued on January 26, 2017. The Final SEIS includes comments on the Draft SEIS, responses, and updated information on the project design. The Final SEIS appeal period closed on February 9, 2017, and no appeals were received. A copy of the Final SEIS is included as Appendix C.

12.4.2 Cost-Effective Analysis

Chapter 8 describes the alternatives development and evaluation. Chapter 9 provides the engineering, cost, nonmonetary factors, environmental information, and overall analysis for the highest-ranking CSO control alternatives for the Ship Canal WQ Project basins. Chapter 11 includes financial information related to the recommended alternative for the Ship Canal WQ Project. The various components of project costs are described, including construction, O&M, and total costs. The chapter also discusses how capital projects are financed, and describes SPU's managerial capability.

12.4.3 Public Participation

Section 9.3 describes the public involvement process for the Ship Canal WQ Project. Appendix B includes public involvement documentation developed for the project by SPU.

12.5 Federal Cross-Cutters

All projects that apply for financial assistance from the SRF for construction must comply with the federal cross-cutting authorities (cross-cutters). These include a number of federal laws, executive orders, and government-wide policies that apply their own terms to projects and activities receiving federal financial assistance, regardless of whether the statute authorizing the assistance makes them applicable. Consistency with federal cross-cutter regulations is based on an August 2011 Ecology guidance document entitled *Revolving Fund State Environmental Review Process and Federal Cross Cutter Guidelines* (Ecology, 2011). The following subsections summarize how the Ship Canal WQ Project will comply with the cross-cutters. SPU will prepare a federal cross-cutter report documenting compliance with the cross-cutters after all federal approvals have been received.

12.5.1 National Historic Preservation Act

The National Historic Preservation Act requires federal agencies to evaluate the effects of federal undertakings on historical, archaeological, and cultural resources and to consult with the State Historic Preservation Officer regarding adverse cultural resources impacts. A review of historical, archaeological, and cultural resources near the Ship Canal WQ Project is summarized in Section 4.10 of this Facility Plan, Chapter 12 of the Final SEIS, and in the *2016 Cultural Resources Assessment* (ESA, 2016). The *Cultural Resources Assessment* has been submitted to the U.S. Army Corps of Engineers in support of the Section 106 Consultation process.

12.5.2 Clean Air Act

The Clean Air Act establishes a comprehensive program for improving and maintaining air quality throughout the United States. A review of existing air quality is summarized in Section 4.3.1 of this Facility Plan, and anticipated impacts from the project are discussed in Chapter 5 of the Final SEIS. This project is anticipated to conform to the State Implementation Plan for nonattainment and/or maintenance areas.

12.5.3 Coastal Zone Management Act

The project area contains designated shorelines and is within King County, which is one of 15 coastal counties in Washington State. Consistency necessitates that the project

must meet the requirements of six enforcement policies, as applicable. SPU will apply for required permits and will comply with all the requirements of the applicable policies once the project design is complete. A Federal Certification of Consistency determination will be prepared and submitted to Ecology for approval once project design is complete and appropriate permits and approvals have been obtained.

Table 12-1. Coastal Zone Management Enforceable Policies

Enforceable Policy	Status of Compliance
Washington's Shoreline Management Act	Project requires shoreline permits for several project work elements. Applications for shoreline substantial development permits or exemptions, as appropriate, will be submitted once designs for work elements are complete. The project is located within the City of Seattle's shoreline management jurisdiction.
State Environmental Policy Act (SEPA)	SPU has prepared a SEPA Final SEIS for the project.
Clean Water Act (401 Certification, stormwater permits)	SPU will apply for and comply with appropriate water quality and stormwater permits when the design for project work elements are complete.
Clean Air Act	As noted above, the project complies with the Clean Air Act.
Ocean Resources Management Act (ORMA)	Does not apply; King County is not in an ORMA-defined ocean county.
Washington Energy Facility Site Evaluation Council (EFSEC)	Does not apply; the project does not require any energy production.

12.5.4 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) prohibits federal agency actions from jeopardizing listed species or adversely modifying designated critical habitat. The following ESA-listed species may occur in the project vicinity:

- Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)—Threatened; critical habitat
- Puget Sound steelhead (*O. mykiss*)—threatened
- Coastal-Puget bull trout (*Salvelinus confluentus*)—threatened; critical habitat

Bald eagles were delisted several years ago but remain protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. ESA-listed species are reviewed in Chapter 6 of the Final Supplemental EIS. A biological assessment (Specific Project Information Forms to supplement the City of Seattle's Programmatic Biological Evaluation) was prepared for the initial West Portal work element (24th Avenue NW Pier

and Outfall Replacement) in support of the Section 7 Consultation process that was initiated with the United States Fish and Wildlife Service and the National Marine Fisheries Service. The consultation with United States Fish and Wildlife Service and National Marine Fisheries Service is still in process. Project effects on ESA-listed species will also be detailed in subsequent biological assessments for future work elements, as appropriate.

12.5.5 Farmland Protection Policy Act

The Ship Canal WQ Project area is not included on the inventory of Prime or Unique Farmlands and will not impact or convert any existing farmlands to nonagricultural uses. Therefore, the Farmland Protection Policy Act regulations and requirements do not apply to the project.

12.5.6 Executive Order 12898, Environmental Justice

Based on federal Executive Order 12898, any “disproportionately high and adverse human health or environmental effects” from projects funded through the SRF program on minority, tribal, or low-income populations must be identified and addressed. Environmental justice considerations were reviewed in Chapter 4 of Volume 4 of the *Plan to Protect Seattle's Waterways, 2014 Final Plan EIS* (SPU, 2014b).

According to the U.S. Census data, the project area has a smaller proportion of minority residents and a higher per capita income than the City of Seattle as a whole. The project is not anticipated to have human health and environmental impacts beyond typical construction impacts. None of the anticipated construction effects are anticipated to cause disproportionately high and adverse effects on minority and low-income populations within the project area.

SPU conducted a public outreach campaign using a variety of methods (including public meetings, webinars, community guides, briefings to community organizations and stakeholder groups, press releases, and other methods). As part of SPU's public process and outreach for the Ship Canal WQ Project, there was focused outreach to populations with limited English proficiency.

12.5.7 Safe Drinking Water Act

Congress passed the Safe Drinking Water Act in 1974 to protect public health by regulating the United States' public drinking water supply. Wastewater construction projects must evaluate the risk of contamination to a sole-source aquifer and integrate appropriate preventive measures. The project area is not within a sole-source aquifer; therefore, the Safe Drinking Water Act regulations and requirements do not apply to this project.

12.5.8 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource projects. Fish and wildlife resources have been carefully considered through coordination with state and federal agencies. Anticipated effects to listed species as a result of the project were detailed in the Biological Assessment for the 24th Avenue NW Pier and Outfall Replacement and will be detailed in subsequent biological assessments for future project work elements, as appropriate.

12.5.9 Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)

EPA and the National Marine Fisheries Service must be consulted on any federally funded actions that may adversely affect essential fish habitats. Essential fish habitats are described in the Biological Assessment prepared for the 24th Avenue NW Pier and Outfall Replacement (currently under review by National Marine Fisheries Service) and will be described in subsequent biological assessments for future project work elements, as appropriate.

12.5.10 Executive Order 11988, Floodplain Management

The Ship Canal WQ Project area is not located within a mapped Federal Emergency Management Agency floodplain; therefore, the regulations and requirements of Executive Order 11988 do not apply.

12.5.11 Executive Order 11990, Protection of Wetlands

The Ship Canal WQ Project area does not include any wetlands; therefore, the regulations and requirements of Executive Order 11990 do not apply.

12.5.12 Wild and Scenic Rivers Act

The purpose of the Wild and Scenic Rivers Act is to preserve the scenic, cultural, historical, recreational, and geologic values of selected rivers. No federally recognized wild and scenic rivers are in the Ship Canal WQ Project area; therefore, the regulations and requirements of this act do not apply.

12.6 Growth Management Act

The GMA, Chapter 36.70A RCW, was adopted by the State Legislature in 1990. The GMA requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans, and implementing the plans through

capital investments and development regulations. The Washington State Legislature passed the GMA as a way to protect the unique Pacific Northwest quality of life. The GMA directs the state's most populous and fastest-growing counties and their cities to prepare comprehensive land use plans that anticipate growth and impact over a 20-year horizon.

12.6.1 Comprehensive Plan Adopted

The City's *Comprehensive Plan: Toward a Sustainable Seattle*, (Comprehensive Plan; City of Seattle, 2005) is a 20-year policy plan designed to articulate a vision of how Seattle will grow in ways that sustain its citizens' values. The City first adopted the Comprehensive Plan in 1994 in response to the GMA.

The Comprehensive Plan makes basic policy choices and provides a flexible framework for adapting to real conditions over time; it is also a collection of the goals and policies the City will use to guide future decisions about how much growth the City should allow and where it should be located. The Comprehensive Plan also describes in a general way how the City will address the impacts of growth on transportation and other City facilities. The initial building blocks of the Comprehensive Plan are the "elements" required by the GMA: land use, transportation, housing, capital facilities, and utilities. The City's plan also addresses neighborhood planning, human development, and the environment.

The City has kicked off a major review of its Comprehensive Plan and is taking a phased approach to the Comprehensive Plan update. Portions of the Comprehensive Plan are being reviewed by the Seattle City Council through annual amendment cycles, the latest being the 2011-2012 amendments adopted through April 2012.

The City of Seattle Department of Construction and Inspections issued a Draft EIS (City of Seattle, 2015d) in May 2015 addressing an update to the City's Comprehensive Plan. The public comment period on the Draft EIS closed in late November 2015. Public feedback received was considered in the Mayor's recommended Plan, which was released in early 2016 with the Final EIS. The Plan was adopted by the City Council in 2016.

12.6.2 Critical Areas Ordinance Adopted

The state GMA requires adopting regulations protecting the functions and values of critical areas, including wetlands, fish and wildlife habitat conservation areas, critical groundwater recharge areas, frequently flooded areas, and geologically hazardous areas. Designated critical areas within the city are protected under the City's Environmentally Critical Areas Ordinance (Seattle Municipal Code 25.09 – Regulations

for Environmentally Critical Areas). This section of the Seattle Municipal Code is based on and implements the City's Comprehensive Plan.

12.6.3 Development Regulations Adopted

As noted in Section 12.5.1, the City's Comprehensive Plan was first adopted in 1994, and it goes through an annual amendment process as needed; it is currently updated through 2010. The Comprehensive Plan outlines the City's overall goals and visions (including development regulations) 20 years into the future.

Additionally, the City's Land Use Code (Seattle Municipal Code Title 23) contains provisions typically associated with determining what use may be made of private property. The code provides detailed use regulations and development standards for different land use zones.

Seattle Municipal Code 25.09 provides the development standards for Environmentally Critical Areas with the goal of promoting "safe, stable, and compatible development that avoids adverse environmental impacts and potential harm on the parcel and to adjacent property, the surrounding neighborhood, and the drainage basin" (Seattle Municipal Code 25.09.010).

12.7 Required Permits and Approvals

Table 12-2 lists the permits and approvals anticipated for the Ship Canal WQ Project.

Table 12-2. List of Anticipated Permits for the Ship Canal Water Quality Project	
Agency/Jurisdiction	Permit/Approval
Federal	
U.S. Army Corps of Engineers	Rivers and Harbors Act Section 10/ Clean Water Act Section 404 Permit Section 408 Decision Letter
U.S. Fish and Wildlife Service/ National Marine Fisheries Service	Section 7 Endangered Species Act Compliance
U.S. Environmental Protection Agency/ U.S. Department of Justice	King County Consent Decree Modification (filed in U.S. District Court October 25, 2016)
State	
Washington Department of Ecology	Facility Plan Approval National Pollutant Discharge Elimination System Construction Stormwater General Permit 401 Water Quality Certification ^a Coastal Zone Consistency Determination ^a State Environmental Review Process Compliance Construction Stormwater General Permit

Table 12-2. List of Anticipated Permits for the Ship Canal Water Quality Project

Agency/Jurisdiction	Permit/Approval
Washington Department of Fish and Wildlife	Hydraulic Project Approval
Washington Department of Archaeology and Historic Preservation	Section 106 National Historic Preservation Act Consultation
Washington Department of Natural Resources	Aquatic Lands Use Authorization
Local	
Seattle City Council	Initiative 42 Approval (Park Lands Conversion)
Seattle Department of Planning and Development	Type V Council Land Use Decision – Concept Approval for City Facility ^b
	Master Use Permit II – State Environmental Policy Act Conditioning Approval ^b
	Master Use Permit II – Shoreline Substantial Development Permit ^b
	Environmentally Critical Areas Approval
	Grading Permit
	Construction Permit
	Temporary Side Sewer Permit
	Electrical Permit
	Plumbing Permit
	Mechanical Permit
	Nighttime Noise Variance
Seattle Design Commission	Project Review
Seattle Department of Transportation	Street Use and Haul Route Permits
	Shoreline Street End Use Permit
Seattle Department of Parks and Recreation	Street Improvement Permit
	Revocable Use Permit
Seattle Public Utilities	State Environmental Policy Act Compliance
	Water Availability Permit
	Joint Project Agreement and Operational Agreement
Public Health – Seattle and King County	Health Permit (Air Gap)
Puget Sound Clean Air Agency	Notice of Construction Permit
	Air Operating Permit
King County	Local Project Approval
	Joint Project Agreement and Operational Agreement (approved on July 27, 2016)
	Industrial Waste Discharge Permit/Construction
	Dewatering Approval

^a These may be included as part of the U.S. Army Corps of Engineers Permit.

^b Applications processed concurrently.

13 References

- Brown and Caldwell. 2011. *Draft 2010 CSO Project Central Trunk Area Basin Calibration*. Prepared for King County Department of Natural Resources and Parks, Wastewater Treatment Division, Comprehensive Planning and Technical Resources. March.
- City of Seattle. 1988. *Comprehensive Combined Sewer Overflow Control Plan*. City of Seattle Water Department.
- City of Seattle. 2005. *Comprehensive Plan: Toward a Sustainable Seattle*. City of Seattle Department of Planning and Development. January.
- City of Seattle. 2007. *Great Blue Heron Management Plan*. Director's Rule 5-2007. City of Seattle, Department of Planning and Development. Available at <http://web6.seattle.gov/DPD/DirRulesViewer/Rule.aspx?id=5-2007>.
- City of Seattle. 2008. *2008 Seattle Greenhouse Gas Inventory*. City of Seattle Office of Sustainability and Environment.
- City of Seattle. 2013. *Seattle Biological Evaluation*. Available at: <http://www.seattle.gov/util/Documents/Reports/SeattleBiologicalEvaluation/index.htm>. Accessed September 2015.
- City of Seattle. 2014. *2012 Seattle Community Greenhouse Gas Emissions Inventory*. Prepared for the Seattle Climate Action Plan by the Stockholm Environment Institute. April.
- City of Seattle. 2015a. *Seattle Bicycling Guide Map*. City of Seattle Department of Transportation.
- City of Seattle. 2015b. Burke-Gilman Trail Extension Project. Available at: http://www.seattle.gov/transportation/BGT_Ballard.htm. Last updated June 18, 2015. Accessed June 20, 2015.
- City of Seattle. 2015c. *Seattle 2035: Your City, Your Future: A Comprehensive Plan for Managing Growth 2015-2035*. Draft. Available at http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2294968.pdf. City of Seattle, Department of Planning and Development. June 8.
- City of Seattle. 2015d. *Draft Environmental Impact Statement for the Seattle Comprehensive Plan Update*. Available at http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2273574.pdf. Prepared by 3 Square

- Blocks LLP, BERK, ESA, Fehr & Peers, SvR, and Weinman Consulting.
Prepared for City of Seattle Department of Planning and Development. May 4.
- City of Seattle and King County. 2012. *Joint King County/Seattle CSO Initiative Work Plan Item 4: Cost-Sharing Method for Joint Capital Projects*. March 26.
- City of Seattle and King County. 2016. *City of Seattle and King County Ship Canal Water Quality Project Joint Project Agreement*, Publication Date May 31, 2016.
Signature Approval Date July 27, 2016.
- Cubbage, J. 1992. *Survey of Contaminants in Sediments in Lake Union and Adjoining Waters (Salmon Bay, Lake Washington Ship Canal, and Portage Bay)*. Available at: <https://fortress.wa.gov/ecy/publications/SummaryPages/92e10.html>. Prepared for Washington State Department of Ecology.
- Gladstone Enterprises, LLC (Gladstone). 2015. *Phase II Environmental Site Assessment Subsurface Assessment Plan*. Prepared for Seattle Public Utilities. September 9, 2015.
- King County. 1998. *Regional Wastewater Services Plan*.
- King County. 1999a. *Combined Sewer Overflow Control Plan Amendment*. King County Department of Natural Resources/Wastewater Treatment Division.
- King County. 1999b. *Sediment Management Plan*. King County Department of Natural Resources/Wastewater Treatment Division.
- King County. 2000. *Combined Sewer Overflow Control Plan Year 2000 Update*.
Prepared by King County Department of Natural Resources/Wastewater Treatment Division and Brown & Caldwell, Inc. June.
- King County. 2004. *Pilot Project Report: Regional Infiltration and Inflow Control Program*.
King County Department of Natural Resources and Parks/Wastewater Treatment Division. October.
- King County. 2008. *2008 CSO Control Plan Update*. Combined Sewer Overflow Control Program. Prepared by King County Department of Natural Resources/Wastewater Treatment Division. June.
- King County, 2009. *Comprehensive Sediment Quality Summary Report for CSO Discharge Locations*. Prepared by King County Department of Natural Resources/Wastewater Treatment Division. December.
- King County. 2012a. *2012 King County Long-Term Combined Sewer Overflow Control Plan Amendment*. Amended October 2012. Prepared by King County, Department of Natural Resources and Parks, Wastewater Treatment Division, Seattle, Washington.

- Lockwood, Chris and Bryan Hoyt. 2012 *Archaeological Monitoring of Secant Pile Placement and Shaft Excavation, North Site, Ballard Siphon Replacement Project, King County, Washington*. Prepared by ESA Paragon. Prepared for King County Wastewater Treatment Division. On file with Department of Archaeology and Historic Preservation, Olympia. May 3, 2012.
- Municipality of Metropolitan Seattle (Metro). 1979. Combined Sewer Overflow Control Plan.
- Municipality of Metropolitan Seattle (Metro). 1980. *201 Facilities Plan*.
- Municipality of Metropolitan Seattle (Metro). 1985. *Final Plan for Combined Sewer Overflow Control*. Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control, Volume III. November.
- Municipality of Metropolitan Seattle (Metro). 1986. *Final Supplemental Plan for Combined Sewer Overflow Control*. Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control, Volume III. An Amendment to Metro's Comprehensive Water Pollution Abatement Plan. Prepared by Culp, Wedner, Culp Consulting Engineers and Ott Water Engineers. July.
- Municipality of Metropolitan Seattle (Metro). 1988. *Final 1988 Combined Sewer Overflow Control Plan—Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control*. An Amendment for Metro's Comprehensive Water Pollution Abatement Plan. Prepared by CWC-HDR, Inc. Consulting Engineers, Ott Water Engineers, Centrac Associates, and Anne C. Symonds & Associates. April.
- Municipality of Metropolitan Seattle (Metro). 1995. *Combined Sewer Overflow Control Plan 1995 Update*. An Amendment for Metro's Comprehensive Water Pollution Abatement Plan. Prepared by Brown and Caldwell/KCM and associated firms. February.
- Municipality of Metropolitan Seattle and King County (Metro and King County). 1998. *1988-1997 Metro/King County CSO Discharge and Sediment Quality Characterization Study*.
- Puget Sound Clean Air Agency (PSCAA). 2014. *2014 Air Quality Data Summary*. <http://www.pscleanair.org/library/Documents/2014AQDS.pdf>. July.
- Riley and Associates. 2010. *Phase II Subsurface Investigation Report: Former Yankee Bar & Grill Property*. Seattle, WA.
- Seattle Municipal Archives. 2015. *Water System*. <http://www.seattle.gov/cityarchives/exhibits-and-education/online-exhibits/a-city-at-work/water-system>. Accessed September 4, 2015.
- Seattle Public Utilities (SPU). 2000. *Combined Sewer Overflow Characterization Study*.

- Seattle Public Utilities (SPU). 2001. *CSO Reduction Plan Amendment*.
- Seattle Public Utilities (SPU). 2005. *CSO Reduction Plan Amendment 2005 Update*.
- Seattle Public Utilities (SPU). 2006. *Combined Sewer Overflow Supplemental Characterization Sampling and Analysis Plan*.
- Seattle Public Utilities (SPU). 2007. *2007 Sediment Survey*. December
- Seattle Public Utilities (SPU). 2010a. *Combined Sewer Overflow Program, 2010 CSO Reduction Plan Amendment*. Prepared by TetraTech Engineering and Architecture Services, Seattle, Washington. May.
- Seattle Public Utilities (SPU). 2010b. *Combined Sewer Overflow Program, Long-Term Control Plan, Volume 1: Flow Monitoring Summary Report, 2008–2010*. Prepared by CH2M HILL, Brown and Caldwell, and GHD. December.
- Seattle Public Utilities (SPU). 2012a. *Long-Term Control Plan Hydraulic Model Report, Volume 2: Ballard*. Prepared by Seattle Public Utilities, CH2M HILL, Brown and Caldwell, MGS Engineering Consultants, Inc. December.
- Seattle Public Utilities (SPU). 2012b. *Long Term Control Plan Hydraulic Model Report, Volume 5: Fremont/Wallingford*. Prepared by Seattle Public Utilities, CH2M HILL, Brown and Caldwell, MGS Engineering Consultants, Inc. December.
- Seattle Public Utilities (SPU). 2012c. *2011 Annual Report Combined Sewer Overflow (CSO) Reduction Program*. March 26.
- Seattle Public Utilities (SPU). 2012d. *Long Term Control Plan Inflow and Infiltration Analysis, NPDES 20 – Montlake, NPDES 30 – Leschi, NPDES 34 – Leschi, NPDES 152 – Ballard*. December.
- Seattle Public Utilities (SPU). 2012e. *Cost Estimating Guide*. Available at http://www.seattle.gov/util/cs/groups/public/@spu/@engineering/documents/webcontent/02_015864.pdf. December 13.
- Seattle Public Utilities (SPU). 2014a. *Draft Plan to Protect Seattle’s Waterways. Volume 1: Executive Summary; Volume 2: Long Term Control Plan; Volume 3: Integrated Plan; Volume 4: Environmental Impact Statement*. Available at <http://www.seattle.gov/util/EnvironmentConservationProjects/DrainageSystem/SewageOverflowPrevention/index.htm>. Prepared for City of Seattle, Seattle Public Utilities, Seattle, Washington. May 29.
- Seattle Public Utilities (SPU). 2014b. *Plan to Protect Seattle’s Waterways, Volume 4: Final Plan Environmental Impact Statement*. Available at http://www.seattle.gov/util/cs/groups/public/@spu/@drainsew/documents/webcontent/01_032053.pdf. Prepared by Environmental Science Associates (ESA),

- CH2M HILL, Brown and Caldwell, Herrera Environmental Consultants, Heffron Transportation, Inc., and PRR. Prepared for City of Seattle, Seattle Public Utilities, Seattle, Washington. December 4.
- Seattle Public Utilities (SPU). 2015a. *Final Plan to Protect Seattle's Waterways. Volume 1: Executive Summary; Volume 2: Long Term Control Plan; Volume 3: Integrated Plan; and Volume 4: Final Plan Environmental Impact Statement.* Available at <http://www.seattle.gov/util/EnvironmentConservation/Projects/DrainageSystem/SewageOverflowPrevention/index.htm>. Prepared for City of Seattle, Seattle Public Utilities, Seattle, Washington. May 29.
- Seattle Public Utilities (SPU). 2015b. *Final Post-Construction Monitoring Program.* May 29.
- Seattle Public Utilities (SPU). 2015d. *CSO Outfall Rehabilitation Plan: Program Years 2015-2020.* August 12.
- Seattle Public Utilities (SPU). 2016.. *Draft Supplemental Environmental Impact Statement. Plan to Protect Seattle's Waterways.* Prepared by Environmental Science Associates; CH2M HILL; Lindsey Amtmann LLC; Greenbusch; Heffron Transportation, Inc.; and Aqua Terra Cultural Consultants (Cultural Resources). Prepared for City of Seattle, Seattle Public Utilities, Seattle, Washington. September 22.
- Seattle Public Utilities (SPU). 2017. *Final Supplemental Environmental Impact Statement. Plan to Protect Seattle's Waterways.* Prepared by Environmental Science Associates; CH2M HILL; Lindsey Amtmann LLC; Greenbusch; Heffron Transportation, Inc.; and Aqua Terra Cultural Consultants (Cultural Resources). Prepared for City of Seattle, Seattle Public Utilities, Seattle, Washington. January 26.
- Seattle Public Utilities and U.S. Army Corps of Engineers. 2008. *Synthesis of Salmon Research and Monitoring: Investigations Conducted in the Western Lake Washington Basin.* Seattle, WA.
- Shannon & Wilson, Inc. 2014. *West Ship Canal CSO Control Project Phase 1 Geotechnical Investigation Plan, Seattle, Washington.* June 6.
- Shannon & Wilson, Inc. 2015a. *Draft Geotechnical Data Report, Ship Canal Water Quality Project, Seattle, Washington.* Prepared for Seattle Public Utilities, July.
- Shannon & Wilson, Inc. 2015b. *Preliminary Geotechnical Assessment Report, Ballard-Fremont/Wallingford Combined Sewer Overflow Reduction Project, Seattle, Washington.* Prepared for Seattle Public Utilities, June.
- U.S. Environmental Protection Agency (EPA). 1995. *Combined Sewer Overflows: Guidance for Nine Minimum Controls.* EPA 832-B-95-003. Available at

- <http://water.epa.gov/polwaste/npdes/cso/Nine-Minimum-Controls.cfm>. Environmental Protection Agency, Office of Water (4204). May.
- U.S. Fish and Wildlife Services (WDFW). 2014. *Coccyzus americanus occidentalis*, Western Yellow-billed Cuckoo: Species Fact Sheet. Available at: <http://www.fws.gov/sacramento/outreach/Public-Advisories/WesternYellow-BilledCuckoo/docs/WYBC-factsheet-southwestlearning.pdf>. Accessed September 8, 2015.
- United States of America and the State of Washington. 2013a. United States of America and the State of Washington, Plaintiffs, v. The City of Seattle, Washington, Defendant. In the United States District Court for the Western District of Washington. Consent Decree. Civil Action No. 2:13-cv-678. Document 6. Filed July 3, 2013. Available at http://www.seattle.gov/util/cs/groups/public/@spu/@drainsew/documents/webcontent/02_030700.pdf
- United States of America and the State of Washington. 2013b. United States of America and the State of Washington, Plaintiffs, v. King County, Washington, Defendant. In the United States District Court for the Western District of Washington. Consent Decree. Civil Action No. 2:13-cv-677 Document 6, Filed July 3, 2013. Available at <http://www.kingcounty.gov/environment/wastewater/CSO/ControlReq.aspx>.
- United States of America and the State of Washington. 2016. United States of America and the State of Washington, Plaintiffs, v. King County, Washington, Defendant. In the United States District Court for the Western District of Washington. Agreed Non-Material Consent Decree Modification. Civil Action No. 2:13-cv-677 Document 7, Filed October 25, 2016.
- Washington Natural Heritage Program. 2015. Review of Washington Natural Heritage Program Geographic Information data set for rare plant species and ecosystems. Available at: <https://fortress.wa.gov/dnr/admins/DataWeb/dmmatrix.html#Natural%20Heritage> Accessed June 26, 2015.
- Washington State Department of Ecology (Ecology). 2008. *Criteria for Sewage Works Design* (The “Orange Book”). Publication No. 98-37 WQ. Available at <https://fortress.wa.gov/ecy/publications/summarypages/9837.html>. Washington State Department of Ecology, Water Quality Program. August.
- Washington State Department of Ecology (Ecology). 2011. *Draft Revolving Fund State Environmental Review Process and Federal Cross Cutter Guidelines*. Department of Ecology Water Quality Program. August.

Washington State Department of Ecology (Ecology). 2015a. Water Quality Assessment and 303(d) List: Current EPA Approved Assessment. Available at: <http://www.ecy.wa.gov/programs/wq/303d/currentassessmt.html>. Last updated May 2015. Accessed September 1, 2015.

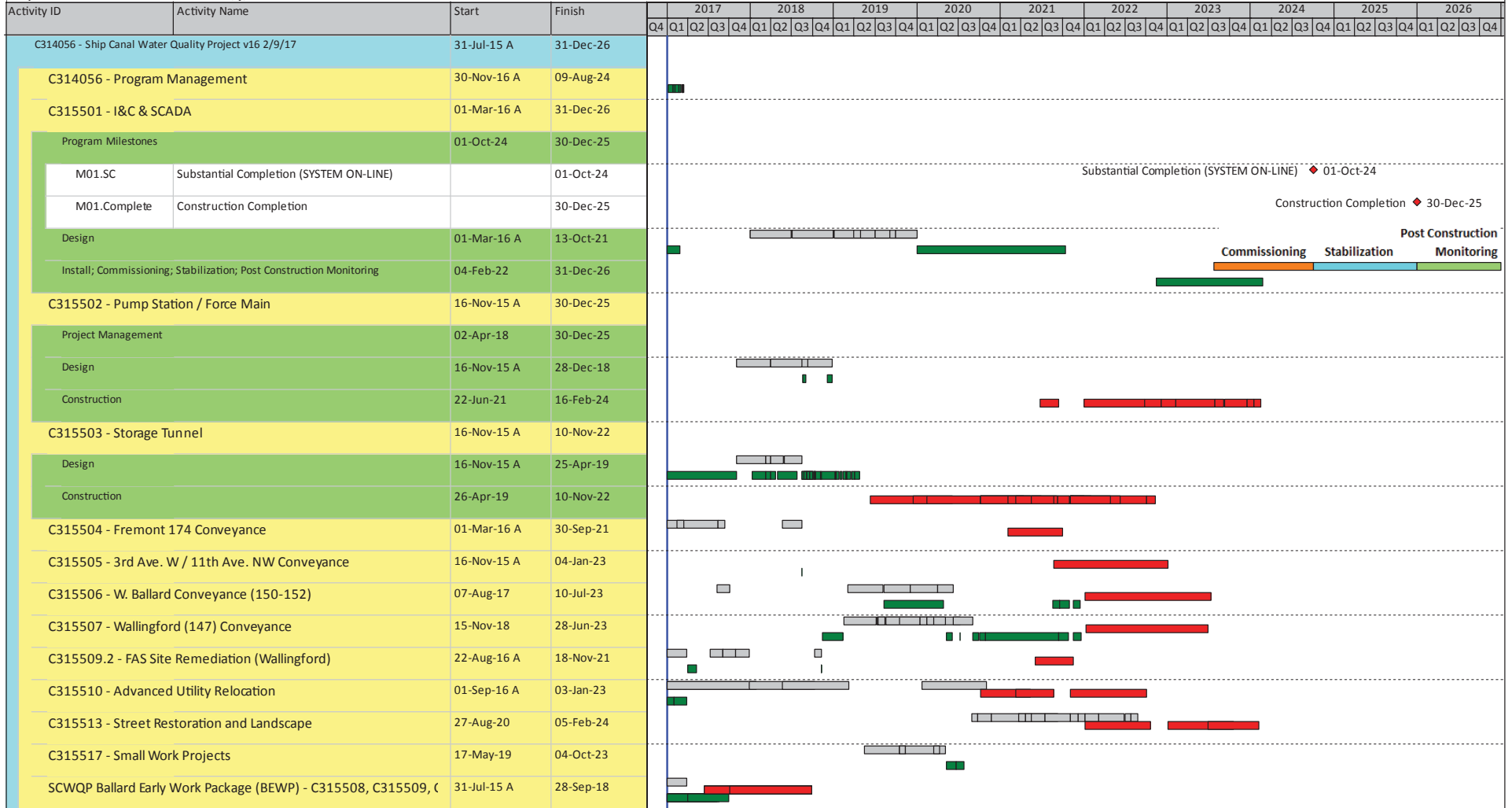
Washington State Department of Ecology (Ecology). 2015b. Washington State – Air Monitoring. Available at <https://fortress.wa.gov/ecy/enviwa/>. Accessed July 2015.

This page intentionally left blank.

Appendix A: Project Schedule

Draft Resequencing v16 Ship Canal Water Quality

Summary Schedule
- Status Date: 2.9.17 -



This page intentionally left blank.

Appendix B: Public Involvement Documentation



Ship Canal Water Quality Project

Ballard and East Ballard Communication and Outreach Summary

Updated 02.23.17

Key activities:

- Programmatic outreach to the following:
 - Seattle Bike Advisory Board – Jeff Aken on July 22, 2015
 - Seattle Freight Advisory Board on August 18, 2015 and February 21, 2017
 - Seattle Pedestrian Advisory Board on October 14, 2015
- Booth at the Ballard Seafood Fest in July 2015 and 2016. Approximately 526 total attendees visited in 2015 and 2016.
- Project briefings took place with the following groups:
 - Groundswell NW on September 16, 2015 and June 21, 2016
 - Ballard Chamber of Commerce on September 23, 2015
 - Ballard Working Session 1 on April 22, 2016, Session 2 on May 10, 2016, and Session 3 on September 29, 2016; February 15, 2017;
 - Ballard District Council on December 14, 2016
 - Pacific Fishermen on June 22, 2016
 - CD Stimson Marina on May 17, 2016
 - Nordic Heritage Museum on August 14, 2015
 - Ballard Terminal Rail Road on September 29, 2015
 - Sue Dills, Marine Commercial Company on August 15, 2016
 - North Seattle Industrial Association on February 23, 2016
- Briefings have reached approximately 80 stakeholders.
- Stakeholder interviews were conducted between April 2015 and August 2016 with Warren Aakervik, with Ballard Oil; Catherine Weatbrook, Seattle City Council District 6; Mike Peck and Ragan Peck, with Peck Properties; Mike Stewart; Executive Director with the Ballard Chamber of Commerce; Sue Dills, with Marine Commercial Company; Doug Dixon and Larry Ward, with Pacific Fishermen; Tom Bayley, with Stimson Marina; and Chris Johnson, with Stabbert Maritime.
- Draft Supplemental Environmental Impact Statement Open House and Public Hearing on October 18, 2016. Advertised in myballard.com.

Geotechnical outreach

- Conducted between February and August 2016
- Contacted the following businesses:
 - Trident Seafoods
 - Hattie's Hat
 - Bitterroot BBQ
 - Percy's and CO. Seattle
 - King's Hardware



King County

Department of Natural Resources and Parks
Wastewater Treatment Division

- Gretchen Goehrend and Assoc.
- Bastille Café
- Canvas Supply
- Western Pioneer
- Canvas Supply
- CSR Marine
- Leader Creek Fisheries
- Euro Products, Inc
- La Marzocco
- Ballard Mill
- Stewart Marine Engine and Mach
- Propel Biofuels
- DA Burns
- Olson Energy
- Fred Meyer
- USPS
- BevMo
- Radtke Marine
- Paving Stone Supply
- Coastal Marine Engine
- Northern Lights Inc
- SDOT
- Ballard Terminal Railroad

Yankee Diner Parking Closure outreach

- Conducted between June and July 2016
- Contacted the following:
 - Pacific fishermen
 - Stabbert Maritime
 - CD Stimson
 - Peck Properties
 - Distributed notices to approximately 35 vehicles parked in and near the former Yankee Diner site

What we heard:

Overall key issues:

- Construction impacts, including noise, dust, pollution, access, parking
- Traffic impacts that affect nearby commercial businesses:
 - Includes NW Market Street, Shilshole Avenue NW, NW 54th Street, 24th Avenue NW, and arterials of NW Ballard Way, and NW 56th Street
- Use of facilities after Ship Canal Project completion (green space/park)
- Conveyance construction impacts to business and homeowners
- Long term impacts of noise, odor, and permanent facilities Loss of public parking
- Concerns for theft and graffiti on SPU property



King County

Department of Natural Resources and Parks
Wastewater Treatment Division

- Access for marine and industrial large scale users along NW 54th Street
- Noise, loss of access to homes if conveyance alignment is located under 56th Avenue NW
- Loss of commerce along NW Market Street
- Odor concerns from facility operations
- Request for green space and community improvements at former Yankee Diner site; opposed by industrial users
- Project remediation schedule coincides with the opening of the new Nordic Heritage Museum, between 26th and 28th avenues NW, and along NW Market Street (noise and vibration concerns)

Public comments and questions included the following:

- Concerns for noise, loss of parking, impacts to traffic, and access to homes and businesses.
- Will project cost and funding sources affect timing and length of project?
- How will construction activities change the use and character of the sites?
- How will odor and spoils be mitigated?
- Location and size of proposed facilities.
- Who will lease/own former Yankee Diner site after completion of project?



Ship Canal Water Quality Project

Fremont Communication and Outreach Summary

Updated 02.23.17

Key Activities:

- Programmatic outreach to the following:
 - Seattle Bike Advisory Board – Jeff Aken on July 22, 2015
 - Seattle Freight Advisory Board on August 18, 2015 and February 21, 2017
 - Seattle Pedestrian Advisory Board on October 14, 2015
- Booths at the Fremont Fair in June 2015 and 2016. Approximately 284 total attendees visited the booths.
- Project briefings took place with the following groups:
 - Fremont Neighborhood Council on August 24, 2015 and October 24, 2016
- Briefings have reached approximately 50 participants.
- Stakeholder interviews were conducted between April 2015 and January 2017 with Eric Pihl, with the Fremont Neighborhood Council; Jessica Vets, with the Fremont Neighborhood Council; Allan Bommer, owner adjacent to Fremont site; and Suzie Burke, with the Fremont Chamber of Commerce.
- Draft Supplemental Environmental Impact Statement Open House and Public Hearing on October 18, 2016. Advertised in mywallingford.com.

Geotechnical outreach

- See Appendix A for residents and business contacted between February and August 2016
- Approximately 10 residential homes along Leary Way NW and 3rd Avenue NW, and along 41st Street were notified of upcoming soil investigation.

What we heard:

Overall key issues and concerns:

- Construction impacts, including noise, dust, pollution, access, and parking
- Traffic impacts that affect neighborhoods and nearby Fremont site:
 - Includes Leary Way, Fremont Avenue, Fremont Place, N 36th Street, and 3rd Avenue NW
- Use of facilities after Ship Canal Project completion (green space/park)
- Construction impacts to Metro bus #40
- Long term impacts of noise, odor, permanent facilities
- General construction fatigue
- Traffic along Leary, adjacent to planned dropshaft location, may be severely impacted during construction
- Metro bus #40 is a vital line that serves the heart of Fremont, and community do not want detours or limited access
- Loss of parking through Fremont
- Stop light request at 1st Ave NW
- New construction is planned by property owner adjacent to drop shaft site



Public comments and questions included the following:

- Concerns for noise, loss of parking, impacts to traffic, and access to homes and businesses.
- Will project cost and funding sources affect timing and length of project?
- How will project team coordinate with SDOT and KC Metro?
- How will construction activities change the use and character of the sites?
- How will odor and spoils be mitigated?
- Location and size of proposed facilities.
- Who will lease/own site after completion of project?



Appendix A

WSC-109: Geotechnical work on NW 36th Street near Leary Way (2/12):

- Da Vinci Pizza and Pasta
- Puget Bridge Supply
- Leukemia and Lymphoma Society
- Our Beginning
- National Automotive Sampling
- Technotherm
- Fleur de Lis Garden Ornaments
- Coffee Hut
- Praxair Distribution
- Intentional 3D
- Access Group
- Washington State Dental Association

WSC-106: Geotechnical work near Leary Way NW at NW 41st Street (3/25):

- Whitecap Construction Supply
- Two Shoe Barbecue
- Hansen & Miller Service Center
- Jet City Label
- Bio Sonics
- Seattle Powder Coat
- The Way Station
- Brown Bear Carwash
- Shell Station
- Ballard Custom Audio
- FreLard Pizza
- Seattle Flagmakers
- Tray Kitchen
- Wescott Welding
- Velopez Bike Fitting
- Activespace – FOUR FLOORS OF OFFICES/WORK SPACES
- Seattle Edge
- Rev Fremont
- Foster Willis Alternative Energy
- Residences between Leary Way NW and 3rd Av, along 41ST
- Piper Hopkins
- Roger Nachmach Glass
- H&H Painting Sleek

WSC-107: Geotechnical work on Leary Way NW at NW 40th Street (3/25):

- Tacoma Screw



King County

Department of Natural Resources and Parks
Wastewater Treatment Division

- Shell Gas Station
- K's Deli
- FreLard Pizza
- Tray Kitchen
- Paint Company at NW 40th
- Technotherm

WSC-110: Geotechnical work on Fremont Place NW at N 36th Street (3/21):

- Harvey Funeral Home
- Nourish Nail Parlour
- FedEx
- Two Smiling Feet
- Royal Grinders
- Sinbad Express
- Pel'Meni Dumpling Tzar
- Hidden Hand Tattoo
- Wax on Spa
- Espresso to Go
- B. Fuller's Mortar and Pestle
- Fremont Cigar
- 9 Million in Unmarked Bills
- Silence-Heart-Nest
- Bellefleur Lingerie Boutique
- Red Star Taco Bar
- High Dive
- Wayi Clothing
- Habitude Salon
- Dave Page, Cobbler
- Sweet Spot Sugaring Studio

WSC-111: Geotechnical work on N 35th Street (2/26):

- Silence-heart-nest
- Jai Thai
- El Camino
- Simply dessert
- Lambs ear
- 9 Million Unmarked Bills
- Essenza
- Tininha's
- Bellefleur Lingerie Boutique



King County

Department of Natural Resources and Parks
Wastewater Treatment Division

VM5: Geotechnical work on NW 36th Street near Leary Way (8/5):

- Da Vinci Pizza and Pasta
- Puget Bridge Supply
- Leukemia and Lymphoma Society
- Our Beginning
- National Automotive Sampling
- Technotherm
- Fleur de Lis Garden Ornaments
- Coffee Hut
- Intentional 3D
- Access Group
- Washington State Dental Association

VM6: Geotechnical work on Fremont Place N and Fremont Avenue N (8/23):

- Pel'Meni Dumpling Tzar
- Hidden Hand Tattoo
- Wax on Spa
- Sinbad Express
- Pie
- Industry Frame Up Studios
- CSz Seattle – Home of Comedy Sports
- Bikini Bar
- Atlas Clothing
- Atlas Theatre
- Espresso to Go
- B. Fuller's Mortar and Pestle
- Fremont Cigar
- Silence-Heart-Nest
- Bellefleur Lingerie Boutique
- Jive Time Records
- Ophelia's Books
- Auto Foreign Sales
- Flying Apron
- Volt Athletics
- Bluebird Ice Cream
- Hotel Hotel Hostel
- Fremont Dental
- Chiso
- UPS Store
- Show Pony
- Peck Properties
- Fremont Chamber



Ship Canal Water Quality Project

Queen Anne Communication and Outreach Summary

Updated 02.23.17

Key activities:

- Programmatic outreach to the following:
 - Seattle Bike Advisory Board – Jeff Aken on July 22, 2015
 - Seattle Freight Advisory Board on August 18, 2015 and February 21, 2017
 - Seattle Pedestrian Advisory Board on October 14, 2015
- Community briefings reached approximately 30 community members:
 - Queen Anne Community Council on November 4, 2015
 - Seattle Pacific University on November 6, 2015 and July 6, 2016
- Stakeholder interview on June 28, 2015 with Dave Church, VP of Facilities Management, Seattle Pacific University.
- Direct outreach to notify nearby businesses about geotechnical work in September 2016
 - King County Environmental Lab
 - Sandella's Flatbread and Café
 - BECU
 - US Bank
 - Northwest Millwork
 - Jamba Juice
 - Styling Etc.
- Draft Supplemental Environmental Impact Statement Open House and Public Hearing on October 18, 2016. Advertised in mywallingford.com.

What we heard:

Overall key issues and concerns:

- Construction impacts, including noise, dust, pollution, access, and parking
- Traffic impacts that affect neighborhoods and nearby West Ewing Park site:
 - Includes W Nickerson Street, near University; 3rd Avenue W near University and West Ewing Park; and W Ewing Street regarding truck traffic
- Use of facilities after Ship Canal Project completion (green space/park)
- Long term impacts of noise, odor, permanent facilities
- Seattle Pacific University would prefer that construction coincide with when students are on summer break
- Concerned about traffic congestion along 3rd St and Nickerson. Seattle Pacific University has even offered to pay SDOT for a separation of pedestrian and vehicle movements to ease the congestion on Nickerson, with no luck
- Concerned that construction noise will be a distraction to students



Public comments and questions included the following:

- Concerns for noise, loss of parking, impacts to traffic, and access to homes and businesses.
- Will project cost and funding sources affect timing and length of project?
- How will construction activities change the use and character of the sites?
- How will odor and spoils be mitigated?
- Location and size of proposed facilities.
- Who will lease/own site after completion of project?
- How will construction affect student access and navigation of University?



Ship Canal Water Quality Project

Wallingford Communication and Outreach Summary

Updated 02.23.17

Key Activities:

- Programmatic outreach to the following:
 - Seattle Bike Advisory Board – Jeff Aken on July 22, 2015
 - Seattle Freight Advisory Board on August 18, 2015 and February 21, 2017
 - Seattle Pedestrian Advisory Board on October 14, 2015
- Booth at the Wallingford Farmers Market in July 2015. Approximately 18 total attendees visited the booth.
- Project briefings took place with the following groups:
 - Wallingford Community Council on August 5, 2015 and February 3, 2016
 - Wallingford Chamber of Commerce on August 20, 2015
 - Wallingford Adjacent Neighbors on October 22, 2015 and December 15, 2015
- Briefings have reached approximately 76 participants.
- Stakeholder interviews were conducted between April 2015 and September 2016 with Stephen Fickensher, with the Wallingford Chamber of Commerce; Carl Slater, with the Wallingford Community Council; Ira Gerlich, partner at EVO; Bryce Phillips, founder of EVO; and Gwendolyn Emminger, property manager of EVO Sports.
- Draft Supplemental Environmental Impact Statement Open House and Public Hearing on October 18, 2016. Advertised in mywallingford.com.

Geotechnical outreach

- Conducted on September 2, 2016
- Contacted the following businesses:
 - Fuelhouse
 - The Whale Wins
 - Evo
 - Fremont Community School
 - Tara's tots
 - MiiR
 - Big Tree Bikes
 - Stone Way Café
 - Sullivan's Residential Services
 - Seattle Book Center
 - Hashtag Cannabis
 - Brooks
- Approximately 22 residential homes along Interlake and Ashworth avenues N were notified of upcoming soil investigation.



What we heard:

Overall key issues and concerns:

- Construction impacts, including noise, dust, pollution, access, and parking
- Traffic impacts that affect neighborhoods and nearby Wallingford site:
 - Includes Stone Way N, N 35th Street, and arterials of Ashworth Avenue N, and N 36th Street
- Use of facilities after Ship Canal Project completion (green space/park)
- Long term impacts of noise, odor, permanent facilities
- Construction exhaustion due to North Transfer Station and private development construction
- Dust from polluted soils, and how that would affect children at Fremont Community School, located next to project site
- Odors and noise from the dropshaft during tunnel operation
- Noise and loss of parking during construction
- Request for a public-private partnership with the City to develop adjacent land into a garden/park for school and public

Public comments and questions included the following:

- Concerns for noise, loss of parking, impacts to traffic, and access to homes and businesses
- Will project cost and funding sources affect timing and length of project?
- How will construction activities change the use and character of the sites?
- How will odor and spoils be mitigated?
- Location and size of proposed facilities.
- Who will lease/own site after completion of project?

Appendix C: Final Supplemental Environmental
Impact Statement (provided on CD)
