



SEATTLE CITY COUNCIL

Legislative Summary

CB 119347

Record No.: CB 119347

Type: Ordinance (Ord)

Status: Passed

Version: 1

Ord. no: Ord 125687

In Control: City Clerk

File Created: 07/11/2018

Final Action: 10/10/2018

Title: AN ORDINANCE relating to Seattle Public Utilities; adopting the 2019 Water System Plan.

Date

Notes:

Filed with City Clerk:

Mayor's Signature:

Sponsors: Herbold

Vetoed by Mayor:

Veto Overridden:

Veto Sustained:

Attachments: Att 1 - SPU 2019 Water System Plan, Volume 1, Att 2 - SPU 2019 Water System Plan, Volume 2

Drafter: bob.hennessey@seattle.gov

Filing Requirements/Dept Action:

History of Legislative File

Legal Notice Published:

☐ Yes

☐ No

Ver- sion:	Acting Body:	Date:	Action:	Sent To:	Due Date:	Return Date:	Result:
1	Mayor	07/31/2018	Mayor's leg transmitted to Council	City Clerk			
1	City Clerk	07/31/2018	sent for review	Council President's Office			
Action Text: The Council Bill (CB) was sent for review. to the Council President's Office							
Notes:							
1	Council President's Office	08/01/2018	sent for review	Civil Rights, Utilities, Economic Development, and Arts Committee			
Action Text: The Council Bill (CB) was sent for review. to the Civil Rights, Utilities, Economic Development, and Arts Committee							
Notes:							

Legislative Summary Continued (CB 119347)

- 1 City Council 09/10/2018 referred Civil Rights,
Utilities,
Economic
Development, and
Arts Committee
- 1 Civil Rights, Utilities, 09/11/2018 discussed
Economic Development,
and Arts Committee
Action Text: The Council Bill (CB) was discussed.
Notes:
- 1 Civil Rights, Utilities, 09/21/2018 pass Pass
Economic Development,
and Arts Committee
Action Text: The Committee recommends that City Council pass the Council Bill (CB).
Notes:
In Favor: 2 Chair Herbold, Member O'Brien
Opposed: 0
- 1 City Council 10/01/2018 passed Pass
Action Text: The Council Bill (CB) was passed by the following vote, and the President signed the Bill:
Notes:
In Favor: 8 Councilmember Bagshaw, Councilmember González , Council
President Harrell, Councilmember Herbold, Councilmember Johnson,
Councilmember Juarez, Councilmember Mosqueda, Councilmember
O'Brien
Opposed: 0
Absent(NV): 1 Councilmember Sawant
- 1 City Clerk 10/03/2018 submitted for Mayor
Mayor's signature
- 1 Mayor 10/05/2018 Signed
- 1 Mayor 10/10/2018 returned City Clerk
- 1 City Clerk 10/10/2018 attested by City Clerk
Action Text: The Ordinance (Ord) was attested by City Clerk.
Notes:
-

CITY OF SEATTLE

ORDINANCE

125687

COUNCIL BILL

119347

AN ORDINANCE relating to Seattle Public Utilities; adopting the 2019 Water System Plan.

WHEREAS, the 2019 Water System Plan provides guidance for planning and managing Seattle

Public Utilities' water system and capital facilities in coordination with growth

management planning by The City of Seattle and other planning agencies in the Puget

Sound Basin; and

WHEREAS, Seattle Public Utilities prepared its 2019 Water System Plan to meet Washington

Department of Health requirements for water system plans and King County

requirements for franchises and permits; and

WHEREAS, the 2019 Water System Plan sets a regional water use efficiency goal to keep

the total average annual retail water use of Saving Water Partnership members under

110 million gallons per day through 2028, despite forecasted population growth, by

reducing per capita water use; and

WHEREAS, Seattle Public Utilities has prepared a Determination of Nonsignificance for the

2019 Water System Plan, which has been submitted to the City Council; NOW,

THEREFORE,

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. The City of Seattle hereby adopts the 2019 Water System Plan, a copy of which is attached to this ordinance as Attachments 1 and 2.

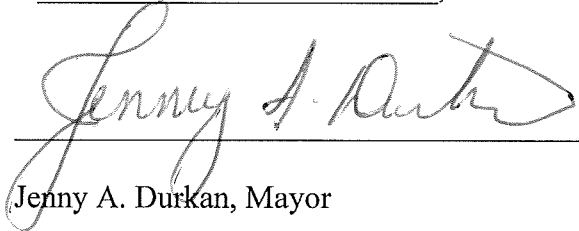
Section 2. This ordinance shall take effect and be in force 30 days after its approval by the Mayor, but if not approved and returned by the Mayor within ten days after presentation, it shall take effect as provided by Seattle Municipal Code Section 1.04.020.

Passed by the City Council the 1st day of October, 2018,
and signed by me in open session in authentication of its passage this 1st day of
October, 2018.



President _____ of the City Council

Approved by me this 5th day of October, 2018.


Jenny A. Durkan, Mayor

Filed by me this 10th day of OCTOBER, 2018.



Monica Martinez Simmons, City Clerk

(Seal)

Attachments:

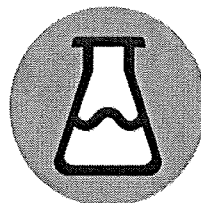
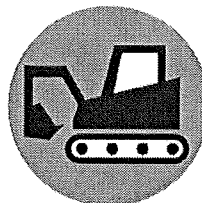
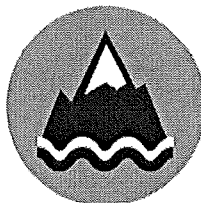
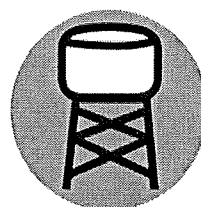
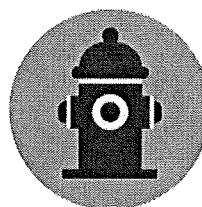
Attachment 1 – 2019 Water System Plan, Volume 1, July 2018

Attachment 2 – 2019 Water System Plan, Volume 2, Appendices, July 2018



**Seattle
Public
Utilities**

2019 WATER SYSTEM PLAN

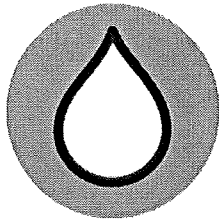


Our Water. Our Future.

FINAL

Volume 1
July 2018

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Seattle Public Utilities
2019 Water System Plan

July 2018

VOLUME 1

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Acknowledgements

The following have contributed to the preparation of this *2019 Water System Plan*:

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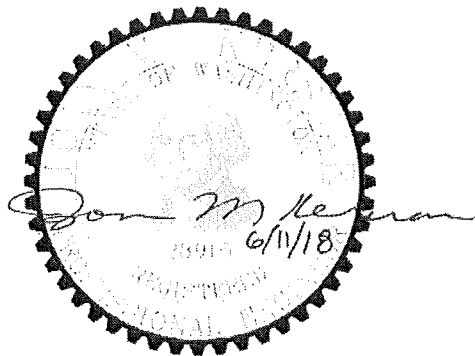
Special appreciation is extended to members of the Seattle Water Supply Operating Board and the Water System Advisory Committee who provided input and comments on preliminary work products for this Water System Plan.

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Certification

Seattle Public Utilities 2019 Water System Plan July 2018

This 2019 Water System Plan for Seattle Public Utilities has been prepared under the direction of the following Registered Professional Engineers:



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Abbreviations

AC	Alternating Current
AMC	Asset Management Committee
AMP	Asset Management Plan
AMR	Automated Meter Reading equipment
ASR	Aquifer Storage and Recovery
AVA	Air Valve Assembly
AWWA	American Water Works Association
BO	Blowoff
BPA	Bonneville Power Administration
CCF	hundred cubic feet
CCL	Contaminant Candidate List
CCR	Consumer Confidence Report
CFP	Capital Facilities Plan
cfs	Cubic feet per second
CI	cast iron
CIP	Capital Improvement Program
COEHHA	California Office of Environmental Health Hazard Assessment
CP	Cathodic Protection
CRPL	Cedar River Pipeline
CUE	Conjunctive Use Evaluation
CWSP	Coordinated Water System Plan
DBP	Disinfection By-Products
DI	ductile iron
DNS	Determination of Nonsignificance
DSL	Distribution System Leakage
EDC	Endocrine Disrupting Compounds
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FCF	Flow Control Facilities
FERC	Federal Energy Regulatory Commission
FWP	Finished Water Pipeline
GIS	Geographic Information System
GMA	Growth Management Act
HAAs	Haloacetic acids
HCP	Habitat Conservation Plan
HISB	High Impact Shutdown Block
HPC	Heterotrophic plate count
I-63 SO	Initiative 63 Settlement Ordinance (Seattle Ordinance 120532)

IDSE	Initial Distribution System Evaluation
IFA	Instream Flow Agreement
IWA	International Water Association
LAF	Limited Alternative to Filtration
LEED	Leadership in Energy and Environmental Design
LF	Linear feet
LIMS	Laboratory Information Management System
LRAA	Locational Running Annual Average
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LT2SWTR	Long Term 2 Surface Water Treatment Rule
MAC	Mycobacterium Avium Complex
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
mgd	million gallons per day
MLPP	Morse Lake Pump Plant
MIT	Muckleshoot Indian Tribe
MTBE	methyl tertiary butyl ether
MWL	Municipal Water Law
NO-DES	Neutral Output Discharge Elimination System
NZMS	New Zealand mud snail
O&M	Operation and Maintenance
OFM	Washington State Office of Financial Management
PHSKC	Public Health Seattle - King County
PPCP	Pharmaceuticals and Personal Care Products
PRV	Pressure regulating valve
psi	pounds per square inch
PSRC	Puget Sound Regional Council
PUMA	Piloting Utility Modeling Applications
RCM	Reliability Centered Maintenance
RCP	Representative Concentration Pathway
RWSP	Regional Wastewater Services Plan
SCADA	Supervisory Control and Data Acquisition
SDCI	Seattle Department of Construction and Inspection
SDOT	Seattle Department of Transportation
SFD	Seattle Fire Department
SPU	Seattle Public Utilities
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
TESS	Tolt Eastside Supply
TESSL	Tolt Eastside Supply Line
TPL	Tolt Pipeline
TTHMs	Trihalomethanes
UCMR	Unregulated Contaminant Monitoring Rule

UDF	Unidirectional Flushing
ug/L	Micrograms per liter
UV	Ultraviolet
UW-CIG	University of Washington Climate Impacts Group
VOC	Volatile Organic Compounds
W.D.	Water District
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
WSDOT	Washington Department of Transportation
WSP	Water System Plan
WTF	Water Treatment Facility
WUE	Water Use Efficiency

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2019 Water System Plan

SUMMARY

Seattle Public Utilities (SPU) manages and operates the water system serving Seattle retail customers and wholesale customers in nearby cities and water districts as shown on the map at the end of this summary. This *2019 Water System Plan* describes how SPU meets current and future water demands, ensures high quality drinking water, and invests in and maintains its water system at the lowest life-cycle cost. While the plan focuses on the next 10 years, longer term outlooks to 2040 and beyond are also discussed.

SPU prepared the plan under regulations adopted by the Washington State Department of Health for public drinking water suppliers. The plan is also consistent with the state's Water Use Efficiency Rule, requirements of the Growth Management Act, and local and regional land use plans.

Key findings and implementation actions are highlighted below, with more detail provided in the chapters that correspond to the headings.

Water Resources



The SPU water supply system consists of surface water reservoirs on the Cedar River and South Fork Tolt River and two wellfields providing groundwater. The system is operated primarily for water supply and protection of instream flows, but also used for hydroelectric power generation and flood management.

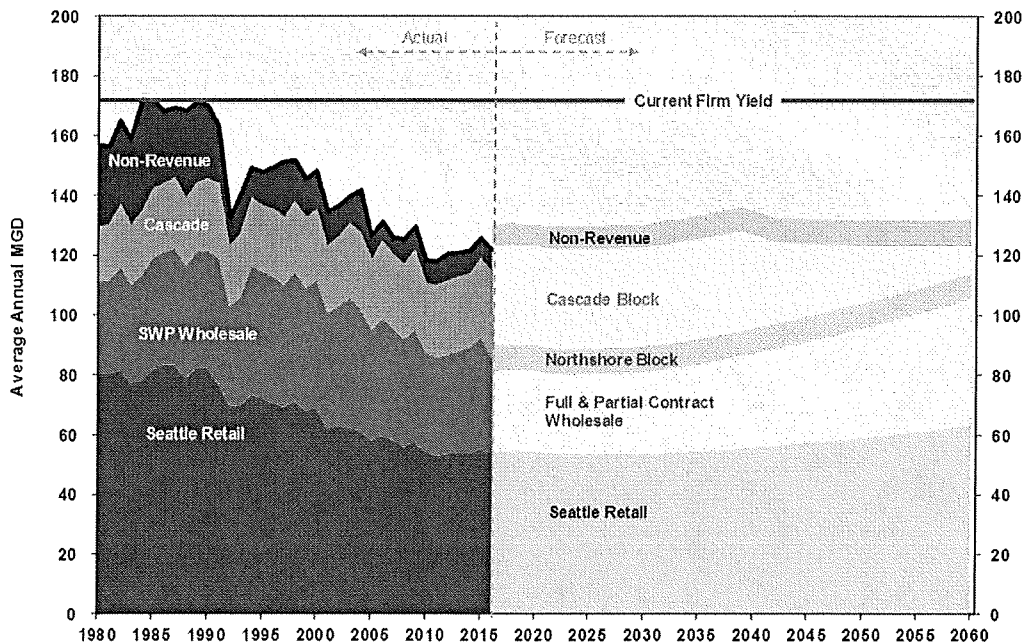
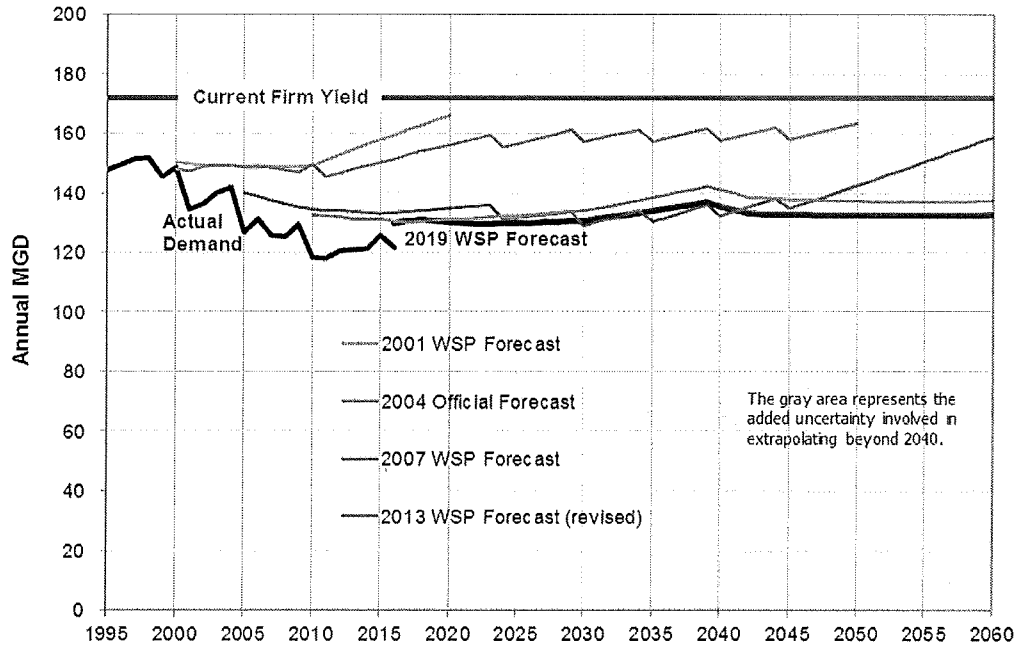
Water Use

- The total population currently served by SPU to its retail and wholesale customers in King and south Snohomish County is about 1.4 million.
- Approximately one-half of the water is sold to SPU retail customers and one-half is sold through wholesale contracts to 19 municipalities and special purpose districts, plus Cascade Water Alliance, who in turn provide the water to their own retail customers.
- Since 1990, total water use has decreased by 28 percent while the number of people being served has increased by the same percentage.
- From 2016 to 2040, the number of households is forecast to increase by 18 percent in the SPU retail service area and by 29 percent in the service areas of SPU's full and partial wholesale water contract holders. Employment is forecast to grow by 29 and 43 percent, respectively, over the same period.
- Total demand is forecast to remain relatively flat through 2030 before rising gradually to a peak of 137 million gallons per day (mgd) in 2039. By 2060, total water demand

from SPU's system is forecasted to have ramped back down to 133 mgd. See the graphs below.

- The primary factors that influence the demand forecast consist of the declining block contract with Cascade Water Alliance and continued reductions in water use by customers.

SPU's Water Demand Forecast



Note: Forecast demand is higher than actual demand in 2016 because the forecast includes all block contract amounts, whereas the actual demand by Cascade and Northshore has been less than their block contract amounts.

Water Conservation

- This plan sets a goal to keep the total average annual retail water use of Saving Water Partnership¹ members under 110 mgd through 2028 despite forecasted population growth by reducing per capita water use.

Water Supply

- The Cedar River supplies approximately 60 to 70 percent of SPU's customer demand for water, and the South Fork Tolt River provides the remainder.
- The current firm yield estimate for the SPU water supply system is 172 mgd, which meets SPU's 98 percent reliability standard for 87.5 years of reconstructed historic inflows.
- Given the new demand forecast and current firm yield estimate for SPU's existing supply resources, no new source of supply is needed before 2060.
- Based on lessons learned from the 2015 drought response, SPU updated its Water Shortage Contingency Plan to allow the SPU General Manager/CEO to authorize the Advisory Stage to begin planning and coordination activities in advance of requesting customer actions.

Climate Change and Future Supply Outlook

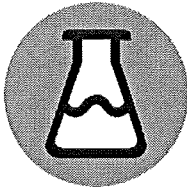
- Updated analysis shows that SPU's water supply system will be increasingly vulnerable to climate change, and SPU identified several adaptation strategies and options to mitigate these impacts. There is a large degree of uncertainty in the timing and magnitude of climate impacts on supply vulnerability, but the trend and range of potential outcomes indicate that planning for increased system resiliency should remain a top priority in coming years.
- SPU will remain engaged in future research on climate change by conducting new assessments on a periodic basis to identify potential impacts and plan for adequate water supply while ensuring that decisions do not result in unnecessary or premature financial and environmental costs for the region.
- SPU also plans to continue investigations of climate adaptation strategies to increase resilience in the water supply watersheds to reduce the future risk of catastrophic wildfire in the face of potential effects of climate change.

Planned Infrastructure and Operational Improvements

- SPU identified infrastructure improvement needs for the water supply system that include Landsburg Dam Flood Passage Improvements and various dam safety studies and projects at the South Fork Tolt Dam and Lake Youngs Cascades Dam.
- SPU will complete analysis of options to improve water supply resiliency under climate change.

¹Since January 2012, Saving Water Partnership members have included SPU, Northshore Utility District, Cedar River W&SD, City of Bothell, City of Duvall, City of Mercer Island, City of Renton, Coal Creek Utility District, Highline W.D., Olympic View W&SD, North City W.D., Soos Creek W&SD, W.D. 20, W.D. 45, W.D. 49, W.D. 90, W.D. 119, W.D. 125, and Woodinville W.D.

Water Quality and Treatment



The SPU water system includes water treatment facilities for the Cedar and South Fork Tolt source waters, in-town disinfection facilities at reservoirs and well sites, and a state-certified water quality laboratory. SPU also manages a cross-connection control program to protect drinking water quality.

Drinking Water Quality

- SPU continues to meet drinking water quality regulations and other aesthetic criteria (i.e., taste and odor).
- SPU's source protection practices (including public ownership and restricted access to the watersheds), water treatment facilities, and distribution system practices have provided excellent quality water that ensures compliance with current and future regulations.
- SPU's corrosion control ensures that water delivered to customers meet lead and copper requirements, and plans to replace service lines with lead components through its service line replacement program.
- SPU will revisit the risk-cost analysis of public access on the Kerriston Road if there is an increase in trespass in the area to determine if additional land acquisition is the preferred approach for mitigating the risk of impairing Cedar source water quality.
- SPU will continue to monitor and characterize limnological conditions in Lake Youngs as it affects Cedar supply operations and treated water quality.
- SPU will operate the water supply system to bypass Lake Youngs to avoid problematic algae from entering the water system.
- SPU will continue efforts to prevent aquatic nuisance and invasive species from being introduced into SPU's drinking water supplies.

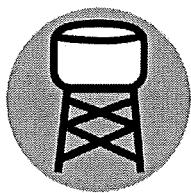
Reservoir Covering/Burying

- SPU will evaluate the need to retain non-potable emergency storage at Roosevelt and Volunteer Reservoirs as part of SPU's water system seismic study.
- SPU will replace the floating covers on Bitter Lake and Lake Forest Park Reservoirs which are nearing the end of their useful life – in particular Lake Forest Park Reservoir.

Water Treatment Facilities

- SPU will be evaluating contract extension options for the Tolt and Cedar Water Treatment Facilities that are in long-term Design-Build-Operate (DBO) contracts, and plan for upgrades as these facilities age.

Water Transmission System



The regional and sub-regional water transmission systems include approximately 193 miles of large-diameter pipes, seven covered reservoirs, 15 pump stations, seven elevated tanks and standpipes, and 131 wholesale customer taps with meters. These systems deliver water from the supply sources to the retail and wholesale service areas.

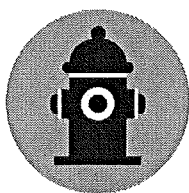
Service Delivery

- SPU has met the wholesale contract requirements for pressure and flow, and there have been no unplanned outages of the transmission pipelines that have exceeded SPU's service level for maximum outage durations.

Transmission Infrastructure

- SPU plans to mitigate the risk of pipe failure in the slide area between the Regulating Basin and Tolt Water Treatment Facility through continued slope monitoring, additional geotechnical data collection, periodic internal inspections, and biannual leak testing, and by implementing additional capital improvements and pipeline stress relief measures when appropriate.
- SPU will continue to implement cost-effective cathodic protection projects for older steel transmission pipelines to protect them from corrosion and extend their service lives well into the future.
- SPU will perform internal video inspection of all lockbar pipelines, and develop a specific plan for their rehabilitation, slip-lining, or replacement, depending on pipeline condition, capacity, and seismic considerations.
- Based on the water system seismic vulnerability study, SPU will improve the overall water system's performance following a major earthquake.

Water Distribution System



The distribution system contains more than 1,630 miles of water mains, six covered reservoirs, two out-of-service open reservoirs, 16 pump stations, six elevated tanks and standpipes, 17,000 valves, and 19,000 fire hydrants, as well as more than 191,000 service lines and meters serving individual residential and non-residential properties in the retail service area.

Service Delivery

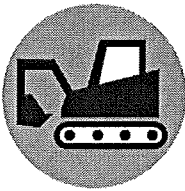
- SPU consistently responded to reported distribution system problems within one hour more than 90 percent of the time.
- SPU plans to improve operational response and customer service by using information from a water main shutdown block analysis in project and emergency shutdown plans.

- The average age of water mains is 71 years, but the rate of water main leaks and breaks remains low, averaging 9 reported leaks or breaks per 100 miles per year in the distribution system.
- While SPU's distribution system leakage was 5.4 percent for 2014 through 2016, which is well below the state standard of 10 percent.

Distribution Infrastructure

- SPU will continue to proactively replace or rehabilitate water mains based on criticality and leak/break history.
- SPU will resume critical valve preventative maintenance and exercising program to ensure adequate and reliable control of the water distribution system grid.
- Based on the water system seismic vulnerability study, SPU will improve the overall water system's performance following a major earthquake.
- SPU will continue to work with the Seattle Fire Department and Shoreline Fire Department to improve fire hydrant maintenance and testing practices, better coordinate communication, and prioritize fire flow improvement projects.
- SPU will continue working with developers where water main replacements or upgrades in redevelopment areas are required to meet current fire flow requirements and water main standards.
- Over the next decade, SPU will need to address impacts to the water system from transportation projects, particularly Move Seattle levy projects.

Capital Improvement Budget and Financial Program

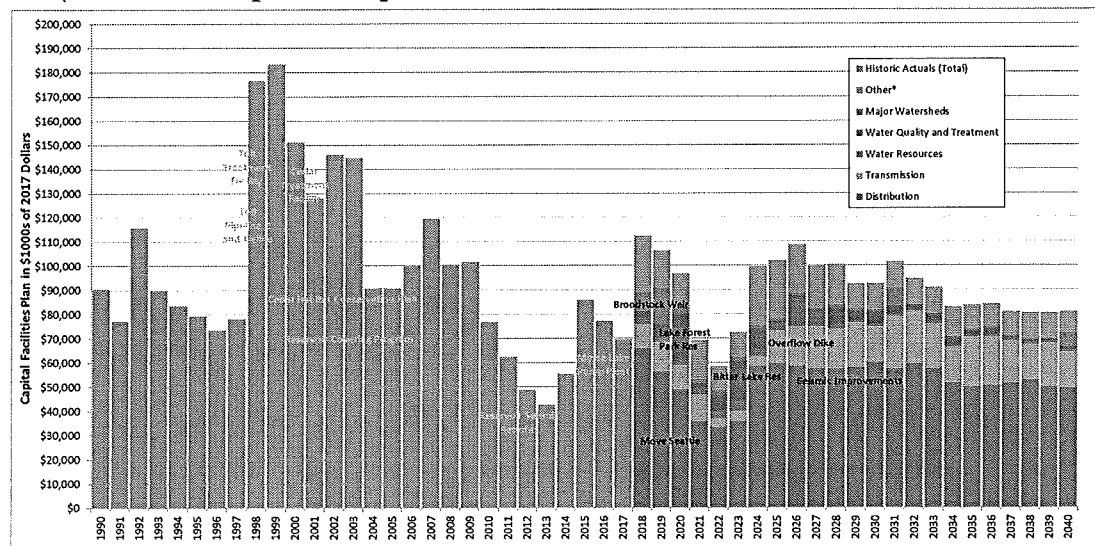


Implementation of this plan requires completion of capital projects, programs, and operations and maintenance activities. SPU uses an asset management approach in selecting which capital improvement projects go forward. The cost estimates presented in the plan are subject to change as the projects are further developed and analyzed, and ultimately require budget approval of the Seattle City Council.

Capital Facilities Plan

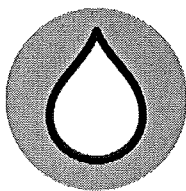
- SPU's Capital Facilities Plan totals to almost \$2 billion from 2019 through 2040 (in 2017 dollars).
- Capital spending is expected to be highest in the earlier years, and on the order of what was spent in the late 2000s, due to significant expenditures associated with the Move Seattle transportation levy (Distribution). See graph below.
- Additional increases starting in 2024 are for watermain rehabilitation in the Distribution system and seismic improvements in the Transmission and Distribution systems.

Historic and Proposed Capital Facilities Plan Spending through 2040
(2018-2023 Adopted CIP, plus 2024-2040 Estimate, in thousands of 2017 dollars)



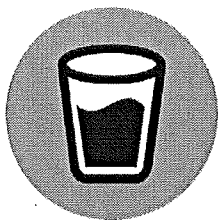
* Other includes Fleets, Facilities, Security, Information Technology, SCADA and other miscellaneous projects.

Conclusion



SPU has been making, and continues to make, significant investments to protect public health, comply with federal and state regulations, and replace aging infrastructure. While SPU has invested in major regional facilities in the past decades, the need is now shifting to significant capital investments to rehabilitate the distribution system and to improve system performance after an earthquake.

Implementation of this water system plan will help to ensure that SPU meets its mission to provide efficient and forward-looking utility services that keep Seattle the best place to live and work for everyone.



CHAPTER 1

INTRODUCTION

Seattle Public Utilities (SPU) provides drinking water to a service area population of 1.4 million within the greater Seattle metropolitan region of King County and portions of southern Snohomish County. This *2019 Water System Plan* describes the near- and long-term plans for the regional water system in accordance with Washington State Department of Health (WDOH) requirements. The focus of this plan is on updates to the water system and programs since completion of the *2013 Water System Plan* and plans for the next 10 years.

To provide context for this plan, this introductory chapter includes a brief history and description of the existing water system and of four core business areas that comprise SPU's water line of business. In addition, this chapter presents an overview of SPU's policies that guide activities for the water system. A summary is provided of SPU's customer service levels for the water system. The chapter also describes the current planning environment, including how this plan is consistent with other relevant planning efforts. Finally, the introduction summarizes the organization of this plan and describes how it meets the requirements of the Washington Administrative Code (WAC).

1.1 SPU'S DRINKING WATER LINE OF BUSINESS

SPU's mission is to provide efficient and forward-looking utility services that keep Seattle the best place to live and work for everyone.

The overarching mission for SPU is to provide efficient and forward-looking utility services that keep Seattle the best place to live and work for everyone. In addition to operating Seattle's regional drinking water system, SPU provides surface water drainage, wastewater, and solid waste services to residents and businesses of Seattle. This plan covers SPU's drinking water line of business. This section provides background on the water system and the water utility's organizational structure.

1.1.1 History of Water Business

Since 1901, the Cedar River has provided water for Seattle. Initially, there was a diversion dam and transmission pipeline on the lower Cedar River at Landsburg and a timber crib dam at Cedar Lake—later renamed Chester Morse Lake. In 1914, a higher masonry dam was constructed to create storage for Seattle's water supply and hydropower generation. Additional pipelines were

added between 1909 and 1954 to meet growing demands for water. Today, the Cedar River supplies 60 to 70 percent of SPU's customer demand for water.

In the late 1950s, several King County suburban communities began to look to Seattle as a source of their drinking water. In response, Seattle began selling water wholesale to these communities, who, in turn, supply it to their own customers.

Although the City began developing its water rights on the Tolt River in 1936, the source was first put to use in 1964. The first phase of the Tolt development was on the South Fork Tolt River, where a reservoir and pipelines were built to increase Seattle's water supply. The South Fork Tolt now provides approximately 30 to 40 percent of the City's water supply.

In 1985, the City began development of two well fields, now called the Seattle Well Fields, north of SeaTac Airport, within the City of SeaTac. These well fields are available to meet the demand for water, especially during the summer peak water use season and emergencies, under temporary water right permits.

1.1.2 System Description

Today, SPU's regional water system is the largest in Washington State. SPU serves 743,800 people in its retail service area and provides water to 19 wholesale customers, plus Cascade Water Alliance, who together deliver SPU water to an additional residential population of approximately 700,000. The water from the Cedar and South Fork Tolt Rivers is treated by ozonation/ultraviolet light and ozonation/filtration, respectively. The Seattle Well Fields are available during peak water use seasons and during emergencies.

SPU's water is delivered to Seattle retail service connections and to SPU wholesale customers through a network of approximately 1,820 miles of transmission and distribution system pipelines. SPU also provides untreated water from the Cedar River Watershed to the City of North Bend to mitigate streamflow impacts of their water supplies.

SPU is not a Satellite System Management Agency, and will not operate nor be responsible for Group A water systems owned by other parties, even if these are within the City of Seattle.

Figure 1-1 shows the major components of the Seattle Regional Water Supply System and the areas currently served by SPU and its wholesale customers.

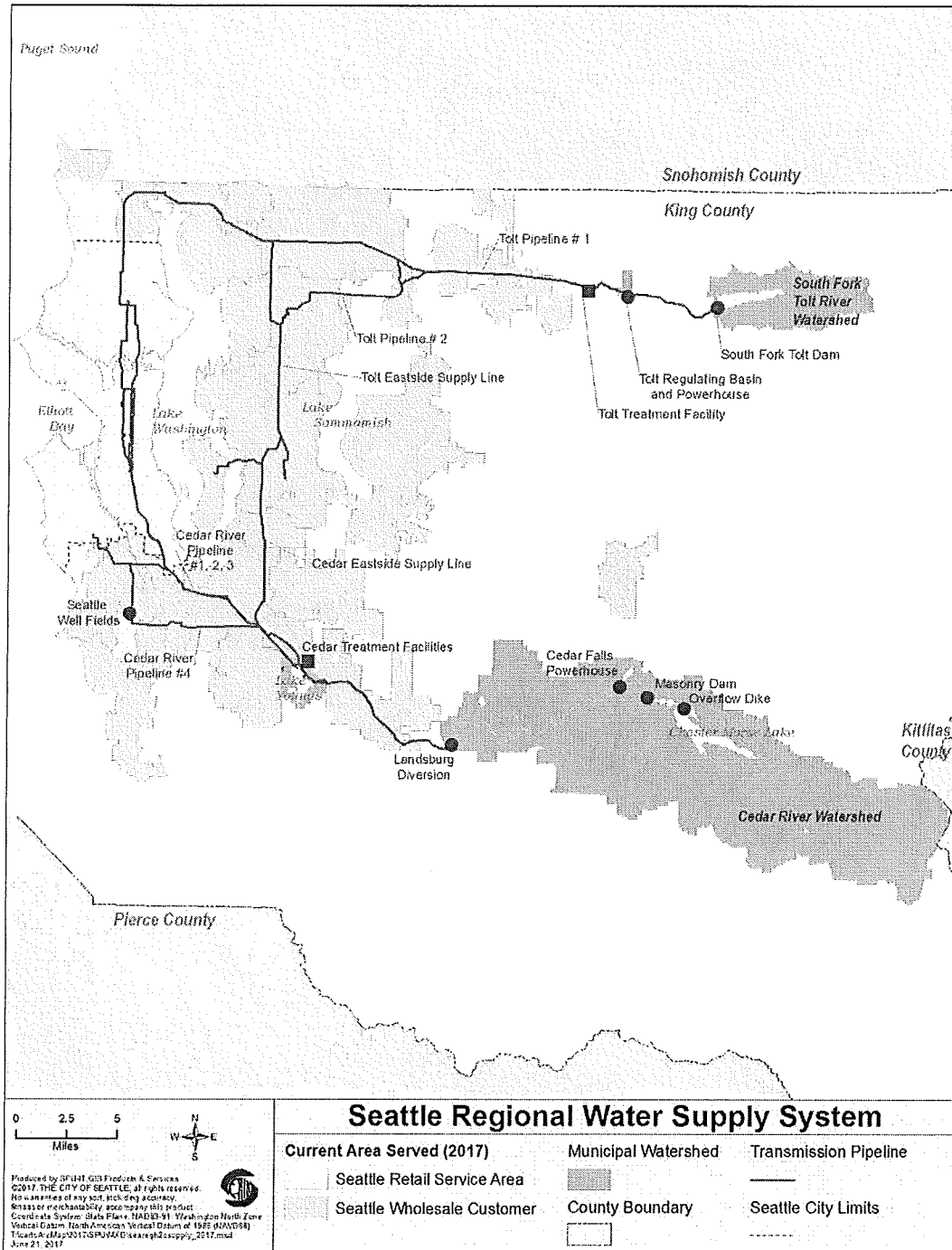


Figure 1-1. Seattle Regional Water Supply System

1.1.3 Business Areas

SPU's water line of business is divided into four business areas: Major Watersheds, Water Resources, Water Quality & Treatment, and Transmission & Distribution.

SPU's water line of business is divided into four core business areas that are focused on key components or sub-systems of its water system. These consist of Major Watersheds, Water Resources, Water Quality and Treatment, and Transmission and Distribution. In addition to the core business areas, there are business areas that are common to and shared by the lines of businesses other than water within SPU. Examples include areas such as Information Technology, Fleets, and Facilities. By organizing the line of business in this manner, SPU is better able to articulate the performance objectives of each sub-system and create accountability in meeting those objectives. The core business areas are described more fully below.

1.1.3.1 Major Watersheds Business Area

The Major Watersheds business area covers management of the South Fork Tolt and Cedar River Municipal Watersheds and Lake Youngs Reservation. Activities are conducted to ensure that source water quality and environmental stewardship goals are met. These activities include stewardship and restoration of watershed land, maintenance of and improvements to watershed bridges and roads, inspection and patrol operations to limit access into the watersheds, operation of the Cedar River Watershed Education Center, limited recreation areas management, and other activities related to protection of source drinking water and natural resources in the watersheds. Watershed operations adhere to protocols established in the most recent *Watershed Protection Plan*, and the *Cultural Resources Management Plan* provides guidelines for protecting cultural resources. In addition, the Major Watersheds business area oversees implementation of watershed land management plans, including the Cedar River Watershed Habitat Conservation Plan (HCP), the Tolt Watershed Management Plan, the Bonneville Power Administration (BPA) settlement agreement, and the Muckleshoot Indian Tribe Settlement Agreement. The business area also provides coordination with salmon recovery plans.

1.1.3.2 Water Resources Business Area

The Water Resources business area consists of the programs and projects whose purpose is to plan for and ensure sufficient water is available to meet anticipated demands. One critical function of this business area is real-time management and operation of mountain reservoir and river facilities for water supply, instream resource protection, and flood management, as well as hydropower

generation. The programs of the Water Resources business area include instream resource management, sockeye hatchery operations, water conservation, dam safety, and water rights. The Water Resources business area also performs water supply and demand forecasting, conservation program planning, reclaimed water/water reuse analysis, development of new sources of supply when needed, climate change vulnerability assessments, and infrastructure planning for water supplies.

1.1.3.3 Water Quality and Treatment Business Area

The Water Quality and Treatment business area covers SPU's drinking water quality and treatment programs, projects, services, and capital assets from the source to customer taps. Key functions of this business area include managing SPU's drinking water regulatory compliance, operation of SPU's water quality laboratory, oversight of the Tolt and Cedar Water Treatment Facilities and their contract operations, implementation of SPU's cross-connection control program, responding to water quality complaints, and overseeing water quality capital projects.

1.1.3.4 Transmission and Distribution Business Area

The Transmission and Distribution business area is comprised of programs and projects affecting the regional and sub-regional transmission systems, which serve both SPU and its wholesale customers, and the distribution system, which serves only SPU's own retail customers. Business area activities include planning and oversight for transmission and distribution pipelines and appurtenances, and operation and maintenance (O&M) of the transmission and distribution pipelines, storage facilities, pump stations, wholesale customer taps, and appurtenances. The Transmission and Distribution business area provides oversight and coordination with related programs, such as seismic analysis and cathodic protection. Billing meter and transportation-related projects that impact both the water transmission and distribution systems are overseen by this business area.

1.2 GUIDING POLICIES

Revised and updated guiding policies for SPU's water business areas were developed and adopted for the *2007 Water System Plan*, and are being carried forward into this plan. These policies are summarized in the table below; see policies for additional details.

Table 1-1. Policies to Guide SPU's Water System Activities

Policy Title (Number)	Policy Statement
Asset Management (WTR-110)	Use Asset Management principles to guide all capital and O&M financial decisions to deliver services effectively and efficiently.
Environmental Stewardship (WTR-120)	Protect and enhance the environment affected by the utility as it carries out its responsibilities to provide drinking water.
Security and Emergency Preparedness (WTR-130)	Institute and maintain appropriate safeguards to protect against security risks and sustain emergency response readiness to ensure the continuity of drinking water services, including fire protection service.
Meeting Customer Expectations (WTR-140)	Provide retail and wholesale drinking water service that responds to changing customer expectations centered on providing reliable, high-quality water, and guided by asset management principles.
Water Service Area (WTR-220)	Continue providing service within the service area boundary as defined in the most recent <i>Water System Plan</i> , allowing for new wholesale customers within that area at SPU's discretion.
Regional Role and Partnerships for Water (WTR-230)	Be a leader in seeking regional cooperation and efficiencies that benefit the customers of SPU, other water utilities, and the environment.
Planning for Uncertainty in Water Supply and Demand (WTR-240)	Base supply investment strategies on future outlooks for supply and demand that incorporate an evaluation of uncertainties using the best available analytical tools.
Water Supply Reliability (WTR-250)	Plan to meet full water demands of "people and fish" under all but the most extreme or unusual conditions, when demands can only be partially met.
Water Resource Selection (WTR-260)	In planning to meet future customer demand, select new sources of supply from all viable options, including conservation programs, improvements to system efficiencies, use of reclaimed water, and conventional supply sources, based on triple-bottom-line analysis.
High-Quality Drinking Water Provision (WTR-500)	Manage drinking water quality from the water source to the customer taps in coordination with wholesale customers to protect public health, comply with drinking water quality regulations, and maintain and improve public confidence in the drinking water quality.
Watershed Protection (WTR-610)	Control human activity and be prepared to respond to emergencies in the municipal watersheds to maximize protection of drinking water source quality.
Transmission System Redundancy (WTR-310)	Consider redundancy in the transmission system on a case-by-case basis, with decisions based on an evaluation of net present value.
Access to Seattle Regional Water System (WTR-320)	Evaluate requests for access to the Seattle regional water system using the <i>Access to Seattle Water System Guidelines</i> , based on the unique characteristics of the water that would be moved through the system.
Distribution System Redundancy (WTR-410)	Consider redundancy for the distribution system on a case-by-case basis, with decisions based on an evaluation of net present value.

1.3 CUSTOMER SERVICE LEVELS

SPU first documented its service levels objectives and targets in its *2007 Water System Plan*. Since then, SPU has tracked its performance relative to those targets. These efforts are part of SPU's asset management initiative as outlined in the *2007 Water System Plan*.

Service levels are statements of desired performance outcomes that are of high priority to customers.

Service levels are statements of desired performance outcomes that are of high priority to SPU's customers or required by regulators. Often these service levels go beyond minimum regulatory requirements. Service levels are largely within the control of SPU and have performance level data that can be accurately and consistently collected and audited. SPU utilizes service level objectives – broad statements of intent – to establish the direction of each of its business areas while using service level targets to establish annual or longer term goals which can be measured through performance outcomes. Service levels are used by SPU to manage its assets, including making decisions on renewal/replacement and O&M practices.

The *2007 Water System Plan* provided levels of service targets to achieve the following objectives:

- Meet the environmental requirements of our water rights and water supply operations.
- Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.
- Promote a high level of public health protection and customer satisfaction with drinking water quality.
- Provide agreed-upon service to wholesale customers.
- Provide adequate pressure for drinking water supplies.
- Respond quickly and effectively to water distribution system problems.

For the most part, SPU has been meeting the service level targets since 2006. More information is provided in the chapters that follow.

1.4 PLANNING REQUIREMENTS

The SPU regional water system is categorized as a Group A community water system with 1,000 or more services and must prepare a water system plan (WSP) for Washington State Department of Health review and approval per Chapter 246-290-100 of the Washington Administrative Code (WAC). These plans must be updated and submitted at least every 10 years. This section describes the planning requirements, as well as how this plan is consistent with other plans.

Note that this water system plan does not cover the Group A water system at Seattle's Cedar Falls Headquarters. That system, as well as other water systems serving outlying SPU facilities, has a separate operating permit and different planning requirements.

1.4.1 WSP Requirements

According to the WAC, the purposes of water system plans are to:

- Demonstrate the system's operational, technical, managerial, and financial capability to achieve and maintain compliance with relevant local, state, and federal plans and regulations.
- Demonstrate how the system will address present and future needs in a manner consistent with other relevant plans and local, state, and federal laws, including applicable land use plans.

The contents of a water system plan are governed by WAC 246-290-100(4). A checklist provided as an appendix lists the plan contents required by the WAC and identifies the specific chapters or appendices of this plan where that required information can be found.

The WAC also provides for a "document submittal exception" process that allows a purveyor to proceed with new distribution mains without submitting construction documents to WDOH for review. This process requires a WDOH-approved water system plan that includes standard construction specifications for these types of projects. SPU is requesting such an exception for new distribution mains. Information needed to support this request is provided in the appendices, including SPU's design and construction guidelines.

WAC 246-290-108 requires that this *Water System Plan* be consistent with local plans and regulations. Consistency review

and certification have been obtained from those local governments with jurisdiction over areas where SPU provides retail water service, which includes the cities of Seattle, Shoreline, Lake Forest Park and Burien (see appendix). This consistency review covers:

- (a) Land use and zoning within the applicable service area;
- (b) Ten-year growth projections used in the demand forecast;
- (c) Utility service extension ordinances of a city or town when water service is provided by the water utility of the city or town;
- (d) Provisions of water service for new service connections; and
- (e) Other relevant elements related to water supply planning as determined by WDOH.

King County has its own consistency review process.

1.4.2 Consistency with Other Plans

SPU is committed to working together with other water providers and regional jurisdictions to address water issues.

In planning to meet future demand, it is necessary to coordinate with other planning efforts to ensure consistency. WDOH has determined that plans that may contain elements requiring local government consistency review include Coordinated Water System plans, Regional Wastewater Plans, Reclaimed Water Plans, Groundwater Area Management Plans, and Capital Facilities Elements of Comprehensive Plans. Other plans that SPU coordinates with include the water system plans of SPU's wholesale customers and adjacent water purveyors, watershed plans and salmon recovery plans. Each of these plans and their relevance to SPU's water resources and water system planning is described below.

1.4.2.1 Coordinated Water System Plans

Three of the four coordinated water system plans (CWSPs) in King County are for areas served by the SPU regional water system, including east King County, south King County, and Skyway/Bryn Mawr. (The fourth CWSP is for Vashon.) A small portion of SPU's retail service area lies within the Skyway/Bryn Mawr Critical Water Service Area, and Shorewood Apartments, located on Mercer Island and served by SPU, is within the East King County Critical Water Service Area. SPU worked with the regional water associations responsible for developing those plans to ensure coordination with SPU planning. SPU staff also maintains regular contact with the East King County Regional Water Association on issues related to SPU's water system plan.

1.4.2.2 Wholesale Customers' Individual Water System Plans

As SPU's wholesale customers update their water system plans for their own water supply and distribution systems, SPU staff coordinates with them so that their water system plans maintain consistency with SPU's *Water System Plan*. For most customers, this includes SPU review of their draft plans in the following key areas:

- Assumptions about the quantities and pressures available from SPU transmission lines.
- Demand forecasts to ensure consistency of population forecasts among Seattle and its wholesale customers.
- Responsibilities that the customer shares with SPU, such as distribution system water quality monitoring.
- Conservation programs.

SPU does not comment on water system plan demand forecast and conservation elements for wholesale customers now purchasing water through the Cascade Water Alliance because SPU is not involved with Cascade planning in these areas.

Since the *2013 Water System Plan*, SPU has reviewed or provided input and comments on water system plans from Bellevue, Bothell, Cedar River, Coal Creek, Lake Forest Park, Mercer Island, Northshore, Redmond, Renton, Skyway, Olympic View, Soos Creek, Tukwila, and Water Districts 49, 90, and 125.

1.4.2.3 King County Comprehensive Plan

Most of SPU's service area is within incorporated areas of King County. A very small part of its retail service area is in unincorporated King County. These areas are located south of the City of Seattle boundary and form portions of the North Highline and West Hill Potential Annexation Areas. In total, fewer than 4,800 customers are located in unincorporated King County. Additionally, SPU's surface water supplies originate in unincorporated King County.

SPU's *2019 Water System Plan* aims to be consistent with applicable policies in the *King County Comprehensive Plan* and *King County Countywide Planning Policies*, both of which were updated in 2016.

1.4.2.4 City of Seattle's Comprehensive Plan

A goal of the City of Seattle is to provide safe, reliable, and affordable utility services that are consistent with the City's aims of environmental stewardship, race and social equity, economic opportunity, and the protection of public health.

Seattle's Comprehensive Plan, *Seattle 2035*, relates to this water system plan with regards to providing safe, reliable and affordable utility services within the city. The comprehensive plan is a 20-year vision and roadmap for how the city will grow while preserving and improving neighborhoods. Planned population increases and changes in land uses are important to how SPU conveys water and make capital investments throughout the distribution system. Key goals and policies in the plan related to city-owned utilities cover service delivery, resource management, facility siting and design, and coordination with the right-of-way.

Although amendments are made annually, the last major update to the comprehensive plan was adopted in 2016. Seattle's Comprehensive Plan remains consistent with the regional growth management strategy (*Vision 2040*) and the *King County Countywide Planning Policies*, and this water system plan is consistent with the goals and policies of Seattle's Comprehensive Plan.

1.4.2.5 Adjacent Purveyors

A number of water purveyors within SPU's water service area and adjacent to existing SPU wholesale customers are not themselves current SPU customers. These include Water District 54, Lakehaven Utility District, City of Kent, City of Auburn, Water District 111, Covington Water District, Mirrormont, Northeast Sammamish Water District, Union Hill, Ames Lake, Carnation, Fall City, City of Mountlake Terrace, and several other smaller purveyors. When water system plans for these systems are received, SPU reviews them for compatibility and consistency in areas such as assumptions about water demand forecasts, transmission needs, and water quality issues.

1.4.2.6 Purveyors Beyond the Boundaries of SPU's Service Area

As a regional water supplier, SPU was an active participant in the *2009 Water Supply Outlook* and the *2012 Regional Water Supply Update*, produced by the Water Supply Forum for the three-county region of Snohomish, King, and Pierce Counties. SPU continues to be an active member on the Forum, which helps ensure coordinated water supply planning throughout the region and between the three major utilities in central Puget Sound: Everett, Tacoma, and Seattle. SPU is currently participating in the resiliency studies being conducted by the Forum.

1.4.2.7 Regional Wastewater and Reclaimed Water Plans

In 2017, King County initiated a new strategic planning effort for four renewable resource programs, including recycled water. The Biosolids, Recycled Water, Energy and Technology Strategic Plan (BRET) is expected to identify goals and strategies, alternatives, and action planning for recycled water. SPU will be involved in that planning effort to the extent that King County involves the MWPAAC advisory committee, on which SPU participates. In addition, SPU will coordinate with King County on opportunities to develop projects with reclaimed water from regional treatment plants. Any distribution of reclaimed water by King County or any other provider within the service area will also need to be closely coordinated to ensure water quality, efficient system operation, and financial sustainability and affordability for all water customers in the service area.

King County has indicated that completion of their Reclaimed Water Checklist suffices to meet consistency with these plans. This checklist is included in the appendices.

1.4.2.8 Groundwater Area Management Plans

The Seattle Well Fields and a portion of SPU's retail service area lie within the South King County Groundwater Management Area. However, there are no approved groundwater area management plans applicable to SPU.

1.4.2.9 Watershed Plans

SPU is dedicated to being a leader in protection of the environment.

Watershed plans in the SPU retail service area are the Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan (2005) and 10-Year Update (2017), and the Green/Duwamish and Central Puget Sound Watershed (WRIA 9) Salmon Habitat Plan (2005). These plans were adopted as part of the Puget Sound Salmon Recovery Plan and approved by the federal government in 2007. This watershed planning occurred within the framework of RCW 77.85, Salmon Recovery. This is not one of the types of plans for which a water system plan must meet WDOH consistency requirements.

The 50-year Cedar River Watershed HCP that SPU developed was agreed to by federal and state resource agencies in 2000 and is now being implemented. SPU continues to be in compliance with the HCP.

1.4.2.10 Salmon Recovery Plans

Seattle participates in salmon recovery processes conducted under the framework of RCW 77.85 in the Water Resource Inventory Areas (WRIA) associated with its water supply and service area: WRIAs 7 (Snohomish River Basin), 8 (Cedar River/Lake Washington Basin), and 9 (Green River/Duwamish Basin). The WRIA 7, 8, and 9 salmon recovery plans recognize that salmon recovery is a long-term effort and include a scientific framework, lists of priority actions, comprehensive action lists, adaptive management approaches, and funding strategies. The City of Seattle has supported salmon recovery through primary sponsorship and implementation of significant habitat restoration and protection projects, and has also addressed salmon habitat protection through its land use and public outreach policies and programs.

As part of WRIA 7, 8, and 9 salmon recovery efforts, Seattle has been a leader in implementing a number of actions. Examples of these efforts include:

- Lower Cedar River habitat acquisition and restoration projects.
- Shoreline and wetland restoration projects along the south shoreline of Lake Washington and in Elliott Bay.
- Development and distribution of a Green Shorelines Guidebook for Lake Washington property owners.
- Receipt of an EPA grant in 2010 to develop Green Shorelines Incentives.
- Receipt of several grants from 2010 to 2016, partnering with Forterra (formerly Cascade Land Conservancy) and King County Noxious Weed Control Program to eradicate knotweed and other invasive plants, and replant native plants on public and private property in lower Cedar River; and conduct community outreach and education on river and stream restoration.
- Purchase and restoration of the Salmon Bay Natural Area downstream of the Locks for habitat benefits.
- Participation in many research efforts with the goal of ensuring effectiveness of restoration projects in Lake Washington, Elliot Bay and on the Duwamish River.
- Acquisition of habitat lands on the Tolt River by Seattle City Light.

- Implementation and primary fiscal sponsorship of the Tolt River Floodplain Reconnection Project, in partnership with King County and multiple grant funders.
- Funding over several years to Tulalip Tribes for juvenile salmon research on the Snoqualmie River.
- Protective land management practices in the Seattle-owned, Cedar River Municipal Watershed to preserve water quality and the natural ecological processes that promote healthy river conditions throughout the Cedar River Basin.
- Fish passage facilities at the Landsburg Dam that reopen over 20 miles of stream habitat for salmon in the protected Cedar River Municipal Watershed.
- Protective stream flow management practices that provide beneficial stream flows for all salmon and steelhead life stages in the Cedar and South Fork Tolt rivers.
- Implementation of the Cedar River Sockeye Salmon Hatchery Program and associated Adaptive Management Plan guided by oversight bodies composed of representatives from federal, state, tribal and local natural resource agencies, academic experts and citizen stakeholders.
- Contributing partner through the Saving Water Partnership to the annual Salmon SEEson salmon-viewing opportunities for the public late summer-fall throughout WRIAs 8 and 9.

The Cedar River Watershed HCP covers many of the costs for the projects recommended in the WRIA 8 plan for the Upper and Lower Cedar River. Staff has successfully leveraged other funding so more can be accomplished. The HCP also provided funding for improving fish passage at the Hiram Chittendon Locks.

1.5 PLAN ORGANIZATION

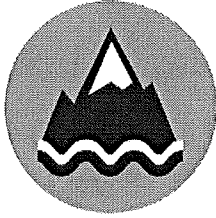
SPU has organized its water utility into the four business areas described previously, and this plan generally follows that organizational structure. The exception are that Transmission and Distribution each have their own chapter, and the Major Watersheds business area does not have its own chapter. SPU's watershed programs and plans to protect drinking water quality are covered in Chapter 3, Water Quality and Treatment, and consistency with watershed and salmon recovery plans are described earlier in this chapter. Each of the next four chapters cover a business area and are divided into the following sections:

- A section summarizing SPU's accomplishments since completion of the *2013 Water System Plan*.
- A service level section that describes SPU's performance in meeting the service levels for that business area.
- A description of the facilities that the business area manages, and the practices it follows in operating and maintaining those facilities. This section focuses on changes since the *2013 Water System Plan*.
- A summary of needs, gaps, and issues that face that business area in the next 20 years and beyond, but with a focus on the 2019-2028 planning period.
- A summary of the plans and actions the business area will be undertaking or continuing as it moves forward to address the needs, gaps, and issues in the next 20 years and beyond.

The last two chapters describe the plan for implementing the actions, including details on the costs and financing approach for plan implementation.

Appendices to this plan are contained in a separate volume as listed in the Table of Contents and should be considered part of this *2019 Water System Plan*.

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CHAPTER 2

WATER RESOURCES

SPU's Water Resources business area focuses on the programs and projects that ensure SPU's customers and instream resources will have sufficient water to meet their needs, both in the present and for the foreseeable future. One important function of the business area is the real-time management and operation of mountain reservoir and river facilities for municipal use while meeting instream flow requirements, supporting hydropower generation, and managing floods. Water resource concerns also include forecasting future water demands, planning for the water conservation program, and evaluating current supply capacity and the need for future additional supply sources and new water rights. The business area also addresses issues related to dam safety and infrastructure maintenance and improvements.

Chapter 2 describes how SPU is prepared to meet water demands in the foreseeable future even with the uncertainties surrounding the potential impacts of a changing climate and population growth.

2.1 ACCOMPLISHMENTS SINCE 2013 WSP

Since completion of the *2013 Water System Plan*, SPU has accomplished the following activities in the water resources business area:

- **Water Conservation:** Met the Water Use Efficiency Goal to reduce per capita water use so that total average annual retail water use of members of the Saving Water Partnership is less than 105 million gallons per day (mgd) from 2013 through 2018 despite forecasted population growth.
- **Morse Lake Pump Plant:** Completed the construction of the Morse Lake Pump Plant and refurbished one of the temporary pump plants for use as a backup.
- **Trust Water Right Donation:** Donated 22,403 acre-feet per year of the Cedar River Water Right Claim into the State Trust Water Right Program to benefit instream flows in the Cedar River below Landsburg Diversion, per the 2006 Muckleshoot Indian Tribe Settlement Agreement.
- **South Fork Tolt Ring Gate:** Refurbished the Ring Gate and associated components, including replacement of the hydraulic

fluid suitable for use over the SPU's drinking water; recoating of the Ring Gate, structural supports, and metallic parts; repair of leaking lifting and gripping systems hydraulic system components; and replacement of the electrical control system.

2.2 SERVICE LEVEL PERFORMANCE

In managing its water resources, SPU has established service levels that are consistent with its regulatory requirements and environmental commitments. In particular, SPU's water resources service levels give emphasis to instream flows and water conservation. By meeting these service levels, SPU has high confidence in having adequate water supply to meet all customer demands. Table 2-1 summarizes these service levels.

Table 2-1. SPU's Service Levels for Managing Water Resources

Service Level Objective	Service Level Target
Meet the environmental requirements of our water rights and water supply operations.	Meet instream flow requirements and performance commitments in tribal, regional, state, and federal agreements and permits.
Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.	Reduce per capita water use from current levels so that total average annual retail water use of members of the Saving Water Partnership is less than 105 mgd from 2013 through 2018 despite forecasted population growth.

SPU has been in compliance with all minimum flow specifications and supplemental flow targets for its Cedar and South Fork Tolt River water supplies, with the exception of some downramping events on the Cedar River, in which water levels fell more quickly than prescribed by the Cedar River Watershed Habitat Conservation Plan (HCP). All events have been reported to the Instream Flow Commission and corrective action described and taken. To date, SPU has also met other performance commitments of the Cedar River Watershed HCP and Muckleshoot Indian Tribe (MIT) Settlement Agreement that do not involve instream flows, including limits on diversions from the Cedar River.

In addition, SPU has achieved its water conservation goals through 2016. Additional information on these achievements is provided in Section 2.3.3. The service level targets for water use efficiency will be updated with the Water Use Efficiency Goal described in Section 2.4.1.1 of this plan.

2.3 EXISTING SYSTEM AND PRACTICES

The total population currently served by SPU and its wholesale customers in King and south Snohomish County is about 1.4 million.

The total population currently served by SPU and its wholesale customers in King and south Snohomish County is about 1.4 million. To provide water to the residents and businesses in its service area, SPU operates and maintains supply facilities associated with its surface water sources and well fields. This section provides an overview of the area to which SPU provides water service. SPU's water demands, including changes over time, and recent water conservation programs are then summarized. The section also summarizes the City's water rights and the quantity of water that can be reliably provided to the service area, or the firm yield of its supply sources. The section concludes with a description of operational changes and maintenance needs for the water supply system.

2.3.1 Service Area Characteristics

SPU's retail service area encompasses 98 square miles that includes the City of Seattle and portions of the cities of Shoreline, Lake Forest Park and Burien, as well as portions of unincorporated King County south of the City of Seattle. SPU also provides retail water service to Shorewood Apartments on Mercer Island and SeaTac Airport. The *2013 Water System Plan* noted a proposed transfer of the area known as the Greenbridge Notch (Wind Rose) from SPU's retail service area to Water District 45, but that area remains in SPU's retail service area.

Besides serving retail customers, SPU provides wholesale water to area cities and water districts, who in turn deliver water to their customers' taps. Figure 2-1 shows these different customer types and service area boundaries, which, in general, includes the City of Seattle, the suburban areas immediately to the north and south, and similar areas extending east of Lake Washington to slightly beyond North Bend.

2.3.1.1 Changes in Demographics

Growth in population, households and employment waxes and wanes with the business cycle. The dot-com bust in the early 2000s was followed by a modest recovery, and housing bubble, that ended in the financial crash of 2008 and Great Recession. More recently, the national economy has been gradually recovering while the local economy – especially Seattle – has boomed. This can be seen in the graphs in Figure 2-2, below, of annual growth rates for households and employment. King County

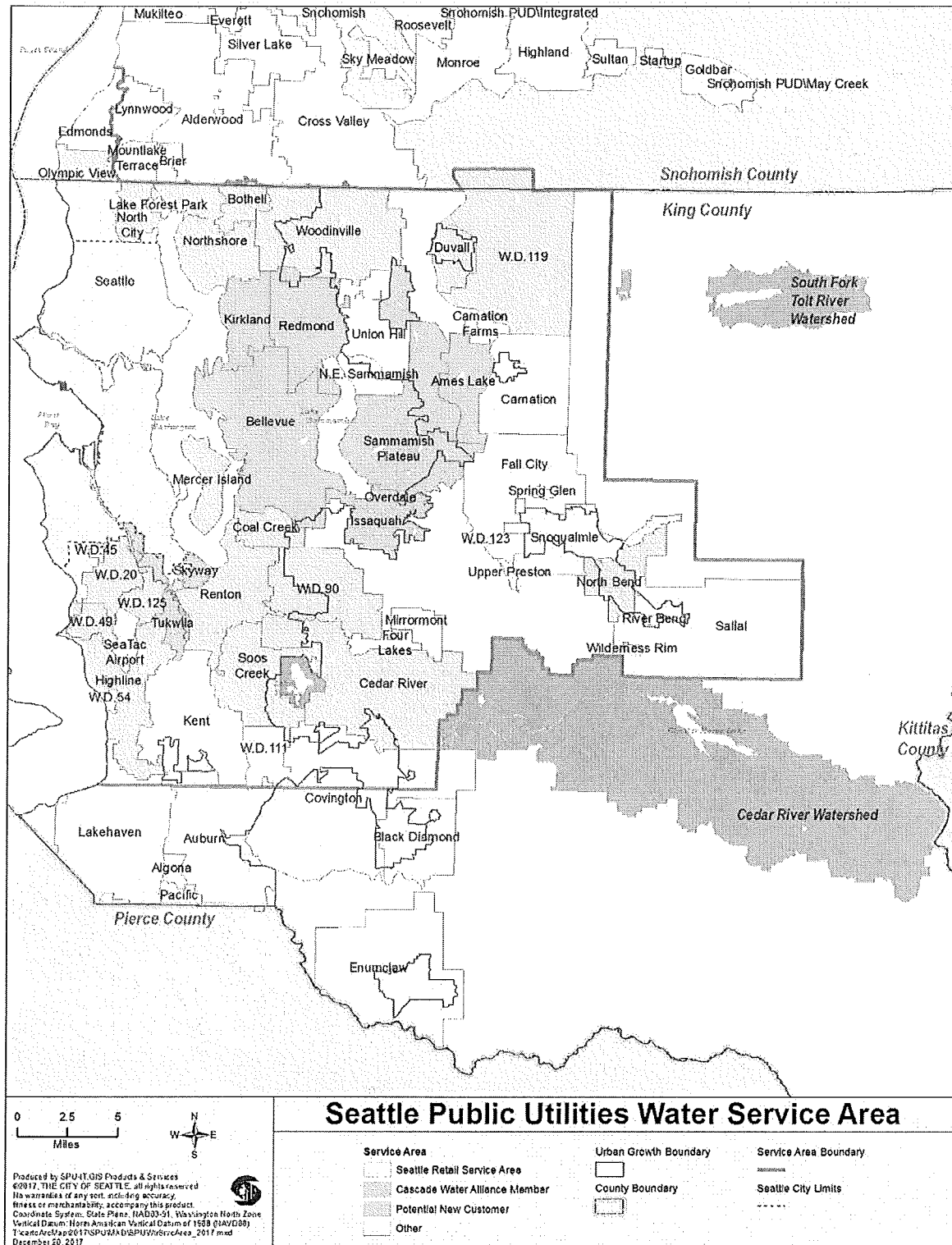


Figure 2-1. SPU's Water Service Area

employment declined in the early 2000s, recovered a bit, fell in 2009, and has been growing since 2011. There is a parallel pattern in population and households, but their growth rates are less volatile.

Growth in the areas surrounding Seattle (wholesale service area) have historically exceeded growth in the city itself (retail service area). That pattern reversed itself in 2013 and since then, Seattle has been growing rapidly, both in absolute terms and relative to the rest of the county. The graphs in Figure 2-2 and Table 2-2, below, show the changes in population, households and employment in King County and the Seattle retail service area.

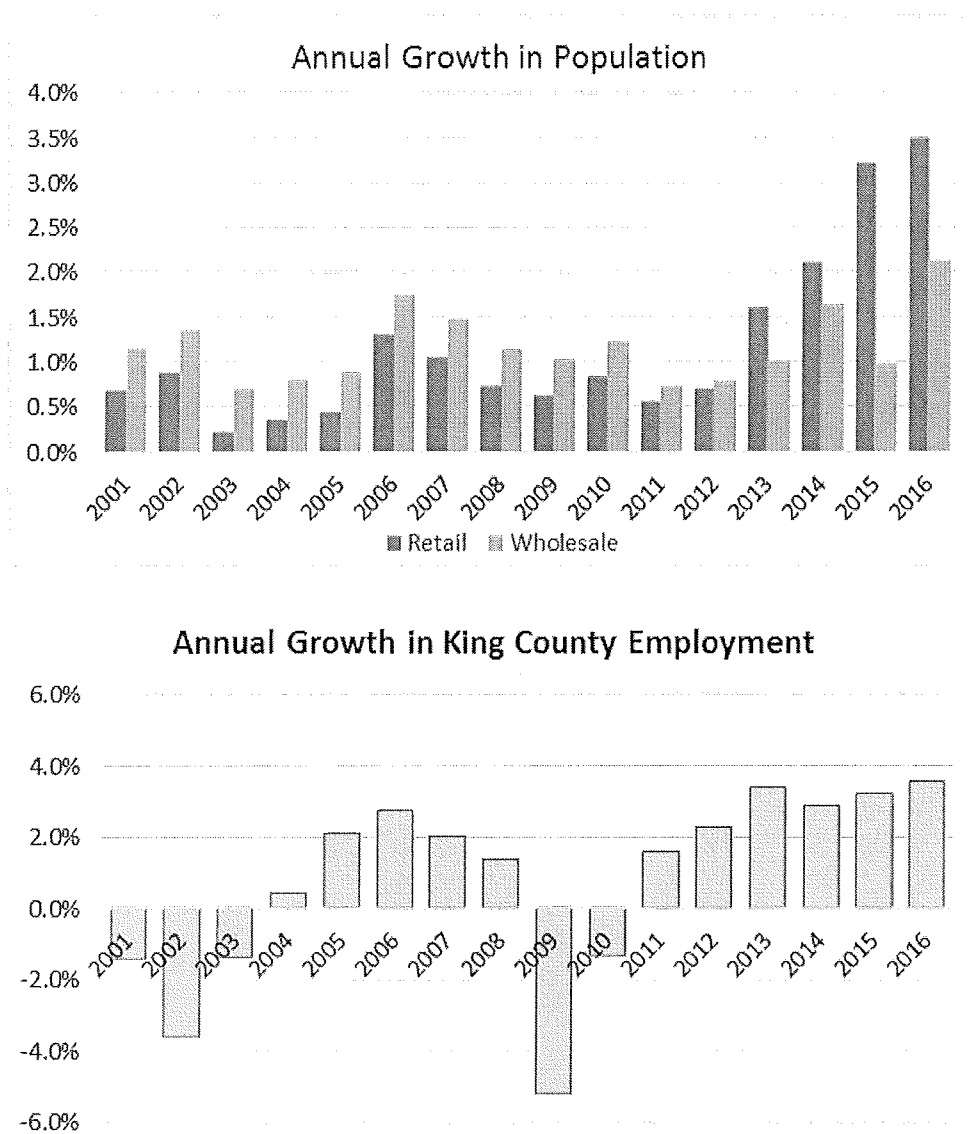


Figure 2-2. Annual Growth in Population and Employment

Table 2-2. Demographic Changes

	Population ¹		Households ¹		Employment ²	
	King County	Seattle Retail	King County	Seattle Retail	King County	Seattle Retail
2000	1,737,379	617,104	711,046	280,191	1,151,214	569,311
2010	1,931,249	662,635	789,232	304,815	1,181,537	509,171
2016	2,105,100	743,796	859,504	324,844	1,375,054	592,115
Change						
2000-2010	193,869	45,530	78,185	24,623	30,322	-60,141
2010-2016	173,850	81,160	70,271	20,028	193,516	82,943
2000-2016	367,721	126,692	148,458	44,653	223,840	22,804
% Change						
2000-2010	11.2%	7.4%	11.0%	8.8%	2.6%	-10.6%
2010-2016	9.0%	12.2%	8.9%	6.6%	16.4%	16.3%
2000-2016	21.2%	20.5%	20.9%	15.9%	19.4%	4.0%
Annual %						
2000-2010	1.1%	0.7%	1.0%	0.8%	0.3%	-1.1%
2010-2016	1.4%	1.9%	1.4%	1.1%	2.6%	2.5%
2000-2016	1.2%	1.2%	1.2%	0.9%	1.1%	0.2%

¹ U.S. Census: 2000 and 2010, estimate 2016

² Puget Sound Regional Council covered employment estimates

2.3.1.2 Retail Customers

SPU delivers water directly to a population in its retail service area of more than 743,800, approximately 81,000 more people than in 2010. This increase has resulted from increased population density from development of vacant property and redevelopment of property to higher densities.

2.3.1.3 Wholesale Customers

SPU's wholesale customers, excluding North Bend, provide SPU water to a resident population of about 700,000. Current Seattle wholesale customers, listed in Table 2-3, include 19 municipalities and special purpose districts, plus Cascade Water Alliance.

In addition to the above, the City of Edmonds and Lake Forest Park Water District have emergency intertie contracts with SPU covering all types of emergencies. SPU also has an emergency water sales agreement with the City of Renton to provide water to the Seattle Regional Water Supply System from Renton.

Table 2-3. SPU Wholesale Water Customers

Full Requirements Contract Holders	
• Bothell, City of	• Water District No. 20
• Cedar River Water and Sewer District	• Water District No. 45
• Coal Creek Utility District	• Water District No. 49
• Duvall, City of	• Water District No. 119
• Mercer Island, City of	• Water District No. 125
• North City Water District	• Woodinville Water District
• Soos Creek Water and Sewer District	
Partial Requirements Contract Holders	
• Highline Water District	• Renton, City of
• Olympic View Water and Sewer District	• Water District No. 90
Block Contract Holders	
• Cascade Water Alliance (Cascade) ¹	• Northshore Utility District
Mitigation Water	
• North Bend, City of ²	

¹ Individual members of the Cascade Water Alliance are the cities of Bellevue, Issaquah, Kirkland, Redmond, Tukwila, Sammamish Plateau Water, and Skyway Water and Sewer Districts.

² Purchases mitigation water from Boxley Creek that is not treated.

Since the last of the 1982 contract holders signed new contracts in 2011, SPU now provides regular municipal water service to its wholesale customers under three contract types:

- **Full Requirements Contracts.** Thirteen of SPU's wholesale customers, as shown in Table 2-3, now receive all of their water supply under full-requirements contracts. These contracts extend to 2062, establish wholesale water rates, and include a provision for an operating board to address issues related to the Seattle water supply system.
- **Partial Requirements Contracts.** As shown in Table 2-3, four of SPU's wholesale customers purchase water from SPU under a partial requirements contract. These utilities have their own sources of supply with which they meet a portion of their demand and depend on Seattle for the rest. Contract provisions pertaining to expiration dates, wholesale rates, Operating Board membership, etc., are identical to the full requirements contracts.
- **Block Contracts.** In 2003, SPU signed long-term contracts for specified amounts of water ("block contracts") with the Cascade Water Alliance (Cascade), whose members are listed above in a footnote to Table 2-3, and Northshore Utility District (Northshore).

- SPU's contract with Cascade is a declining block contract, which was last amended in July 2013. Under this contract, SPU will provide an average annual fixed block of 33.3 mgd to Cascade through 2039. The block will then be reduced by 2 mgd per year for the three years beginning in 2040, and 1 mgd per year thereafter until it reaches 5.3 mgd in 2064. Cascade chose to not participate on the Operating Board and the regional conservation program.
- Northshore's block contract is for 8.55 mgd on an average annual basis for the duration of the contract, which is expected to meet all the district's water supply needs into the future. Northshore provides water directly to its retail customers and participates on the Operating Board and in the regional conservation program.

2.3.2 Historical Water Consumption

Are people using less water?

Yes! Today, people in SPU's regional water supply system use 28% less water than they did in 1990 while the population grew by the same percentage.

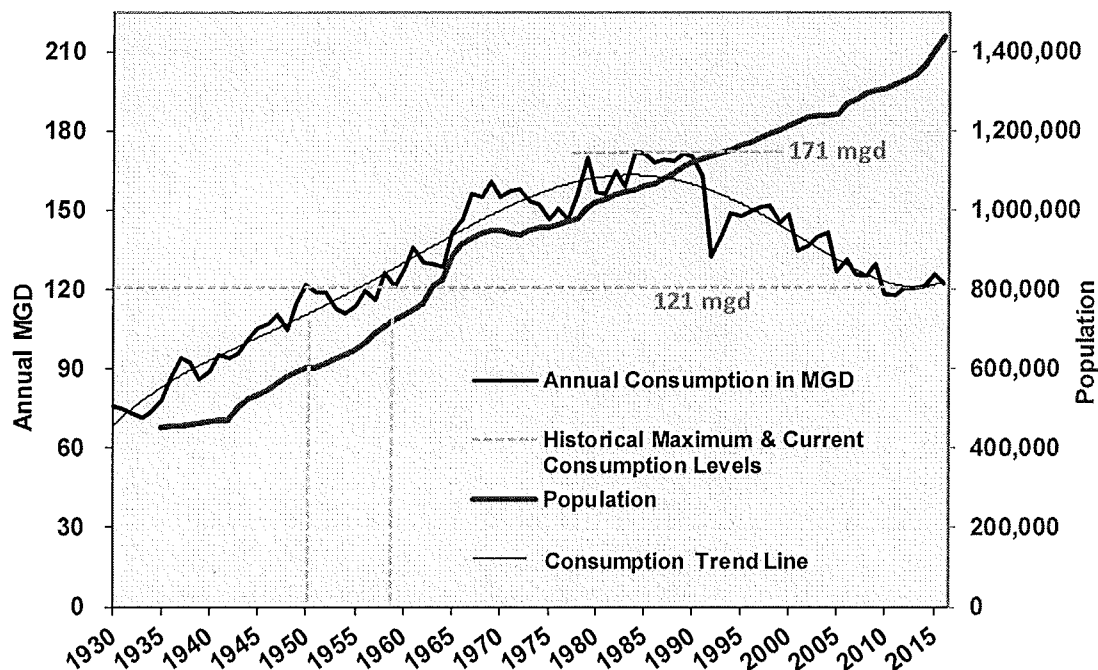
For most of Seattle's history, water consumption increased along with its population. However, that link was broken around the late 1980s when consumption reached its highest level. Since then, water consumption has steadily declined despite continued population growth. Currently, consumption is lower than it has been since the 1950's when the population serviced was only half what it is now.

Figure 2-3 displays Seattle system water consumption and service population since 1930. While population has steadily risen, water demand leveled off during the 1980's before dropping off sharply in 1992 due to a drought and mandatory curtailment measures. Since then, the combined effects of higher water and sewer rates¹, new federal and state plumbing codes, utility conservation programs, and improved system operations have kept water consumption significantly below pre-1992 drought levels. Between 1990 and 2016, consumption decreased by 28 percent while population increased by the same percentage. Total water consumption *per person* is now 44% less than it was in 1990.

After more than 20 years of steady decline, water consumption has leveled off in the past five years at about 121 mgd (weather-adjusted). This suggests that the current rate at which water use efficiency is improving (due to efficiency codes, conservation

¹ Seattle's sewer rates are based, in part, on water use, so that using less water may result in a lower sewer bill, thereby increasing a retail customer's incentive to conserve water.

programs, and other factors) is roughly in balance with the forces putting upward pressure on water consumption (growth in population and the economy).



Note: Population is adjusted to reflect the proportion of resident service area population actually using SPU water (i.e., excludes those that receive water from other sources).

Figure 2-3. Population Growth and Water Consumption from SPU Sources

Peak water demand has fallen even more than annual average demand since the 1980's when hot summer weather could produce peak day consumption of over 330 mgd. In the last 10 years however, peak day consumption has averaged around 200 mgd even on the hottest days. Peak month and peak week consumption have also been trending downwards over the past twenty years, but not as steeply as peak day consumption.

2.3.3 Water Conservation Programs

SPU has had a long-standing commitment to water conservation. SPU began its water conservation program in 1981, with a regional program for SPU and its wholesale water customers focusing on education for the residential sector. Over the years, the program has been expanded to add elements for all customer sectors and to go well beyond education.

The program has been modified in focus areas and intensity over time to reflect the changing drivers for conservation. In the early

years, conservation programs helped educate customers about efficient water use and successfully built an ethic of stewardship. Later, conservation programs helped to decrease water use when the need for a new source of supply was forecast.

SPU's water conservation program includes both a regional program and a City of Seattle specific program, as described further below. Collectively, the programs offer a comprehensive set of services that help residents and businesses use water wisely. The services include education, technical assistance, and financial incentives.

SPU's conservation program fulfills a variety of legal requirements, commitments and stakeholder expectations including the following:

- Washington State Water Use Efficiency Rule
- 2000 SPU Cedar River Habitat Conservation Plan
- 2006 SPU Muckleshoot Indian Tribe Settlement Agreement

There are several key underlying principles for the conservation program, including the following:

- No Sacrifice: Conservation is a long-term effort to maximize the efficient use of water; it should not result in a loss of service or sacrifice by customers.
- Customer Choice: Conservation is a voluntary choice by customers.
- 3-Prongs: Conservation should include education, technical assistance, and financial incentives.
- Comprehensive: Conservation should provide opportunities for all customer classes, include both hardware and behavior measures, and include both indoor and outdoor measures.
- Regional: The program should provide opportunities across all service areas.
- Cost Share: Financial incentives should include a cost share with customers.
- Beyond-Code: Financial incentives should focus on water use rates that go beyond the plumbing code.
- Partners: Partnerships should be leveraged to reduce costs when possible.
- Equity: Opportunities to reach under-served populations should be sought out.

The conservation program has been leveraged for drought curtailment several times over the decades. While there is a significant difference between long-term conservation and short-term curtailment, having an established conservation program has been a key component of the response strategy during droughts when customer water curtailment was necessary.

2.3.3.1 Regional Conservation 2013-2018

SPU implements a regional water conservation program on behalf of itself and 18 of its wholesale customers¹. The program is branded as the Saving Water Partnership.

Management of the Saving Water Partnership program is performed jointly by SPU and the wholesale customers. The strategic direction of the program, including the goal, broad focus areas, and budget levels, is decided by the Seattle Water Supply System Operating Board. Program design and implementation is provided by the Conservation Technical Forum, which includes staff-level employees from SPU and the wholesale customers. SPU staff provide a base-level implementation of the programs across the Saving Water Partnership service area, as well as an additional effort within SPU's service area. Similarly, wholesale customer staff are responsible for specific outreach and implementation within their service areas.

Additionally for SPU's retail service area, the customer-based Water System Advisory Committee provides additional customer input and feedback on conservation goals and programs.

Selection of measures for the conservation program is based on numerous considerations including the following:

- Understanding of national fixture and appliance codes and standards,
- Reviews of regional conservation potential analysis,
- Participant and program evaluations and research to assess program effectiveness, and

¹Since January 2012, Saving Water Partnership members have included SPU, Northshore Utility District, Cedar River Water and Sewer District, City of Bothell, City of Duvall, City of Mercer Island, City of Renton, Coal Creek Utility District, Highline W.D., Olympic View Water and Sewer District, North City W.D., Soos Creek Water and Sewer District, W.D. 20, W.D. 45, W.D. 49, W.D. 90, W.D. 119, W.D. 125, and Woodinville W.D.

- Opportunities for partnerships to leverage water utility funds.

An avoided cost of supply is not a formal consideration because the demand forecast has shown that a new source of supply is not needed until sometime after 2060.

The measures included in the 2013-2018 regional Saving Water Partnership program are shown in Table 2-4.

Table 2-4. 2013-2018 Saving Water Partnership Conservation Program Measures

Education and Technical Assistance
• Classroom presentations for K-12 grade students • Outreach at community festivals and events • Water efficient gardening classes for residents • Garden hotline to answer questions about water-efficient gardening and other topics • Landscape professional training • Gardening brochures and fact sheets • Technical assistance to residential and commercial customers on irrigation efficiency • Technical assistance to commercial customers on indoor efficiency • Website full of information, tips, rebate information, etc (www.savingwater.org) • How-to-videos on conservation topics • Conservation hotline (206-684-SAVE)
Financial Incentives
• Toilet rebates for single family, multifamily, and commercial customers • Irrigation system rebates for single family, multifamily, and commercial customers • Urinal rebates for commercial customers • Commercial dishwasher rebates • Commercial ice machine rebates • Commercial food steamer rebates • Coin-operated clothes washer rebates • Cooling tower improvement rebates • Rebates up to 50% of installed cost for all other commercial water-related equipment

2.3.3.2 Seattle-Only Conservation 2013-2018

SPU has implemented a low-income water conservation program in the City of Seattle since 2001. The program originated with City Council Ordinance 120532 (also referred to as the Initiative 63 Settlement Ordinance), which established the “Everyone Can Conserve” program. The program committed the City to pursue conservation beyond the regional program in SPU’s retail service area focusing on low-income housing through 2010. The program was successful and has continued post-2010 as part of the City’s sustained efforts to help low-income customers manage their water and sewer bills.

The low-income water conservation program features free fixtures and installation for qualified single family and multi-family customers. The primary target fixtures are toilets and common-area clothes washers, although showerheads and faucet aerators are also included.

From program inception through the end of 2016, the Seattle low income water conservation program has served over 6,000 single family households and nearly 20,000 multifamily households. The cost of the program has averaged approximately \$650,000 dollars annually between 2013-2016.

2.3.3.3 Water Use Efficiency Goal and Program 2013-2018

SPU worked with the Operating Board to set a six-year regional Water Use Efficiency goal for 2013 to 2018. The drivers for the 2013-2018 regional goal were to:

- Ensure core capacity is available to deliver conservation programs that prepare the utility to be resilient for curtailment events and future supply challenges from climate change, as well as help customers use water wisely
- Preserve customers' ethic of conservation as one element of stewarding our water resources and the environment
- Meet regulatory and contractual requirements.

The official 2013-2018 regional Water Use Efficiency goal was:

“Reduce per capita water use so that the total average annual retail water use of members of the Saving Water Partnership was less than 105 mgd from 2013 through 2018, despite forecasted population growth.”

The regional goal was formally adopted by SPU when the City Council adopted SPU's *2013 Water System Plan*. The governing body of each of the other 18 members of the Saving Water Partnership also adopted the regional goal.

The Saving Water Partnership achieved its goal every year since 2013. The total average annual retail water use of members of the Saving Water Partnership in 2016 was 94.4 mgd. Annual reports for other years can be found at www.savingwater.org. The goal and SPU's performance towards the goal are submitted to WDOH annually and are reported to SPU's retail customers in SPU's annual Drinking Water Quality Report.

Achievement of the regional goal is accomplished by customers who change their behavior and/or install efficient equipment. Customers engage in these efficiency measures for a variety of reasons including concern for the environment, desire to save money, and availability of new fixtures and appliances that meet higher efficiency codes and standards. Attainment of the regional goal includes water savings in the following three categories:

- **Conservation Program:** Water savings that result from the Saving Water Partnership program, as well as the Seattle-only low income program.
- **Codes and Standards:** Water savings that occur as customers replace older, less-efficient fixtures with new, more-efficient models that meet or exceed federal or state codes or standards. These savings are also achieved as new buildings are built using efficient code-compliant equipment.
- **Independent:** Water savings that result from customers who make efficient choices, independent of utility-sponsored programs or codes and standards.

2.3.4 Existing Water Supply

To meet the water demand of its customers, SPU operates and maintains two surface water sources of supply, each of which has associated infrastructure (such as reservoirs, dams, pump stations, and pipelines) and two well fields. This section describes the capacities of each of Seattle's water sources and provides information concerning the City's water rights and firm yield.

2.3.4.1 Supply Sources

Seattle obtains approximately 60 to 70 percent of its raw (untreated) drinking water supply from the Cedar River and most of the remaining 30 to 40 percent from the South Fork Tolt River. Seattle's two well fields are available to provide peak season and emergency supply. Tables showing historic production from these sources is included in the appendices. Additional information about each supply source is included below. The few changes that have occurred since the *2013 Water System Plan* are noted.

Cedar River. The Cedar River Municipal Watershed is located in the Cascade Range within southeast King County and comprises 91,500 acres of forest, streams, wetlands and lakes that provide habitat for a variety of fish and wildlife species. The watershed contains the 1,680-acre Chester Morse Lake, formed behind Masonry Dam. The reservoir stores 13 billion gallons (40,000 acre-feet) between elevations 1563 and 1538 feet. As noted in the

2013 Water System Plan, the normal refill level of 1563 feet was authorized after completion of the Cedar Moraine Improvements. Also, as described in later sections, the Morse Lake Pump Plant was recently installed to more reliably access water stored below elevation 1538 feet.

Water stored in Chester Morse Lake flows downstream to the Landsburg Diversion Dam and fish passage facility, which is located about 14 miles downstream from the Masonry Dam. Here, some of the water is diverted through pipelines to Lake Youngs Reservoir while the remainder supports instream resources in the Cedar River. Lake Youngs Reservoir, with a useable storage capacity of approximately 1.5 billion gallons (4,600 acre-feet), provides additional storage and regulates flows to the Cedar Water Treatment Facility.

Some of the Cedar River source water is lost from Masonry Pool, the portion of the reservoir between the Overflow Dike and Masonry Dam, via seepage into a moraine on the Pool's northern bank. Water seeps out of the Masonry Pool at different volumes depending on the surface water elevation in the reservoir and Masonry Pool. When water is relatively abundant, it fills an underground "reservoir" or aquifer, and a portion returns to the river in about four weeks. This aquifer return flow provides cool water to the Cedar River in the summer which is beneficial for instream resources. About 75 to 80 percent of the water that leaks from Masonry Pool is "stored" in this way and finds its way back to the Cedar River, while the remainder ends up in the Snoqualmie River basin. Some of this seepage is discharged through Hobo Springs. In 2009, piping was installed to divert water from Hobo Springs to Boxley Creek for the city of North Bend to mitigate use of their wells on the Snoqualmie River. The amount of water provided was 0.09 mgd in 2016.

South Fork Tolt River. The South Fork Tolt River Municipal Watershed is located about 13 miles east of Duvall in King County and comprises approximately 12,000 acres, with over 8,300 acres owned by the City and the remainder owned and managed by the U.S. Forest Service. The South Fork Tolt Reservoir, which went online in 1964, provides 18.3 billion gallons (56,160 acre-feet) of storage. Water from this reservoir is conveyed to the Tolt Regulating Basin and the Tolt Water Treatment Facility. To provide beneficial flows and water temperatures for instream resources in the river downstream of the dam, releases are made from different depths using existing intake gates.

Seattle Well Fields. In addition to the major surface water supplies, Seattle operates two small well fields in the City of SeaTac to provide drought capacity and emergency supply, as needed, under a temporary water right permit. The Riverton well field has two wells, and the Boulevard Park well field has one well. In total, the three wells can supply up to 10 mgd for approximately four months. Without the wells, firm yield, described below, would fall by approximately 1 mgd.

2.3.4.2 Water Rights

Seattle holds various water rights for use of water from the Cedar River and South Fork Tolt River, as well as permit applications for the Seattle Well Fields. Also, Seattle has water right applications on file with the Washington State Department of Ecology (Ecology) for potential future sources of supply, as indicated by the Water Rights Evaluation contained in the appendices.

In 2016 and as agreed to in the 2006 Settlement Agreement between the City of Seattle and the Muckleshoot Indian Tribe, SPU donated 22,403 acre-feet per year, the equivalent of 20 mgd over the course of a year, of its Cedar River Water Right Claim into the State Trust Water Right program. The donated quantity is a portion of the Cedar River Water Right Claim above the diversion limits agreed to with the Tribe. The purpose of this 35-year donation is to benefit instream flows in the Cedar River below the Landsburg Diversion Dam.

Also, SPU received a water right permit in 2007 to capture and put to use rainwater that falls on rooftops of structures in the combined and partially separated sewer basins of the City of Seattle. Captured rainwater can be used for non-potable municipal purposes on that property and offset the need for potable water. This permit includes a map for those properties covered. Reporting for the water permit occurs with updates to SPU's water system plans, with the current report provided in the appendices.

An evaluation of specific Seattle water right claims, permits, and applications as called for in WDOH planning guidelines is included as an appendix. Forecasts indicate that Seattle does not need to apply for any new water rights within the next 20 years.

2.3.4.3 Firm Yield and Supply Reliability

Firm yield is the amount of water that SPU is able to supply system-wide at a given delivery pattern while meeting the supply reliability standard, instream flow requirements, treatment and

transmission capacity, and other system constraints, including diversion limits for the Cedar River as set forth in the 2006 Agreement with the Muckleshoot Indian Tribe and the Cedar River Trust Water Right. Firm yield is expressed as an average annual delivery rate in million gallons per day (mgd) from all sources operating conjunctively. Calculating firm yield for SPU's existing supply sources is critical to ensuring that SPU can meet existing and future demands reliably. The firm yield can be compared to long-term forecasts of water demand to determine when new sources or additional conservation programs need to be online to maintain the desired level of supply reliability. Firm yield calculations are also useful in determining the quantity of water that can be expected from a potential new source of supply.

Firm yield of SPU's water supply is estimated to be 172 million gallons per day.

SPU uses a computer simulation model to calculate the firm yield from its existing water supply sources and potential new water sources. This model is known as the Conjunctive Use Evaluation (CUE) model. The model is used with 87.5 years of reconstructed historic flow records that takes into account past weather and hydrologic variability to produce a system-wide firm yield estimate. SPU's supply reliability standard is 98 percent. Therefore, SPU's firm yield is the amount of water that is assured for delivery in all but the driest 2 years without lowering reservoirs below normal minimum operating levels. The firm yield calculation was updated in 2016 to include inflow datasets from October 1928 through March 2016 and to represent current operating conditions, namely the use of the current early spring refill target of elevation 1563 feet by March for Chester Morse Lake and the use of a revised monthly demand distribution based upon the actual demand of 2006 through 2014. The firm yield estimate also assumes use of the Seattle Well Fields. The result was that the combined firm yield of all SPU supplies is currently estimated to be 172 mgd.

2.3.5 Operations

The surface water supply facilities on the South Fork Tolt and Cedar Rivers are operated primarily for water supply and protection of instream resources, but are also used for hydroelectric power generation and flood management. The reservoirs are drawn down and refilled each year. Reservoir and river operations have changed little since the *2013 Water System Plan*. The most significant change was installation of the new Morse Lake Pump Plant to improve reliability of that system. Also, the upper flow levels used to prevent scour of salmon redds were raised, as described below.

The groundwater supply facilities at the Seattle Well Fields are also available, if needed. The wells were last used in 2015, and groundwater elevations measured since the *2013 Water System Plan* are provided in the appendices.

Should a drought or other water supply emergency occur, SPU would activate the Water Shortage Contingency Plan (WSCP), an updated of which is contained in the appendices. The WSCP was last activated in 2015, and based on lessons learned from that response, SPU has updated its WSCP as described below.

2.3.5.1 Morse Lake Pump Plant

The Morse Lake Pump Plant (MLPP) project, completed in 2017, replaced two existing 120-mgd floating barge-mounted pump stations with a new, more energy-efficient 240 mgd floating pump station to improve the reliability of water supply from the Chester Morse Reservoir, meet municipal demands, and manage flows for instream resources in the Cedar River during dry weather conditions. Additionally, one of the existing 120-mgd floating barge-mounted pump stations was refurbished to serve as a backup. These facilities provide access to water stored below elevation 1538 feet in Chester Morse Lake that would otherwise not be available by gravity flow.

The new MLPP is a floating structure consisting of modular steel pontoons that form the 80-foot by 40-foot barge and four submerged axial-flow pumps with in-line fish screens. The pumps provide a cumulative 240 mgd pumping capacity through four 48-inch diameter, 500-foot long discharge pipelines that convey water through the discharge dike where it flows by gravity to Masonry Pool. To facilitate rapid deployment and demobilization of the pump plant and minimal use of a dive team, the platform design incorporates guide cones, allowing easier plant docking with permanently stationed pipelines. During operations, electrical service is supplied using a rental diesel generator and the project-supplied trailer-mounted substation, and transmitted through permanently installed submerged and buried cables.

When the pump plants are not in use, they are moored in a Chester Morse Reservoir cove where it is protected from frequent high-wind and-wave conditions. The system is mobilized either for periodic testing or infrequent pumping operations. When pumping operations are needed, the MLPP is transported to an operating position where it is docked with submerged pipelines near its outlet to draw additional water from below the outlet level and discharge

dike during low reservoir conditions (below approximately elevation 1538 feet).

2.3.5.2 Scour Protection Levels

Whenever possible, SPU limits releases to the Cedar and South Fork Tolt Rivers to levels that prevent scour of redds (salmon egg nests) which would cause loss of the eggs. In coordination with the Instream Flow Commission, SPU completed a salmon redd scour study on the Cedar River which changed the redd scour threshold to 2200 cfs from 1800 cfs at the U.S. Geological Survey (USGS) Renton Gage (12119000). Similarly, SPU worked with the Tolt Fish Advisory Committee (TFAC) to complete a 2-year salmon redd scour study on the South Fork Tolt River which increased the year round 550 cfs redd scour threshold to 1100 cfs from September 2 to January 14 and 900 cfs from January 15 to September 1 at USGS Gage 12148300. It is notable that the 350 cfs redd scour threshold in the South Fork Tolt River at USGS Gage 1214800 was determined to no longer be needed. The new thresholds provide SPU with more flexibility to release water during the flood management period.

2.3.5.3 Water Shortage Contingency Plan

The Water Shortage Consistency Plan (WSCP) provides guidelines for SPU to manage water supply and demand in the event of a water shortage. The plan enables SPU to maintain essential public health and safety and minimize adverse impacts on economic activity, environmental resources and the region's water use preferences. Water shortages could result from forecasted, progressive events such as droughts, as well as unforeseen, static events such as system failures like a major infrastructure break. The WSCP has four water shortage response stages – Advisory, Voluntary, Mandatory, Emergency – which are typically implemented progressively depending on the magnitude of the water shortage, unless more aggressive action is warranted.

SPU last activated its WSCP in 2015. Based on lessons learned from that event, SPU has revised its plan for inclusion in this *Water System Plan*. A key change allows the SPU General Manager/CEO to authorize the Advisory Stage to begin planning and coordination activities in advance of requesting customer actions. The City of Seattle Mayor, upon recommendations from the SPU GM/CEO, authorizes the Voluntary and Mandatory Stages in which customer actions are requested. The revised WSCP is included in the appendices and provides more details on response actions.

2.3.6 Maintenance

SPU has developed Asset Management Plans (AMPs) as part of its asset management process. Each AMP covers a class of assets or facilities, and describes the condition, performance, failure history, and cost of maintenance and renewal for those assets. AMPs are 3- to 5-year planning documents that provide a framework to assess the current status of a category of assets and guide their management, including operation, maintenance, renewal/replacement strategies, and capital investments. AMPs are updated and refined periodically.

AMPs involving water resources assets and facilities include:

- Tolt Watershed Reservoirs and Dams (2013)
- Lake Youngs Reservoir and Dams (2010)

An AMP will also be developed for the facilities at Landsburg.

Each of these AMPs ensure that the dams are maintained for operability and safeguard against damage or failure in large floods, earthquakes, malevolent acts, and general deterioration from aging. The Dam Safety Section of the Washington State Department of Ecology (Ecology) or, for the Tolt Dams, the Federal Energy Regulatory Commission (FERC) regulate the maintenance of Seattle's dams to ensure continued safe performance. Both Ecology and FERC require regular inspections of these dams and related infrastructure, such as spillway gates and dam failure warning systems. These inspections can result in requirements for maintenance work or major capital improvements.

2.4 NEEDS, GAPS, AND ISSUES

Needs, gaps, and issues facing the Water Resources business area include appropriately planning for water supply in the face of uncertainty around the potential impacts from a changing climate and improving water supply infrastructure and operational practices to make the best use of existing supplies. The Water Use Efficiency Goal and program for the 2019-2028 time period is also described, along with an updated water demand forecast. Each of these specific issues is discussed in the following section, along with how SPU plans to address them.

2.4.1 Future Water Demand and Supply

There are uncertainties affecting both future water demand and future water supply. Future water demand is dependent on population growth, income, conservation, climate, weather, and

other factors, such as changes in water appliance efficiency standards. Future water supply depends on the condition of water supply infrastructure, operating constraints, climate, the feasibility of developing new supplies as needed, and other factors, such as legal and regulatory issues. SPU has developed water demand forecasts and analyzed future water supply using frameworks that incorporate these relative uncertainties. The results of SPU's analyses are described in the following sections.

2.4.1.1 Water Use Efficiency Goal and Program 2019-2028

Towards the end of the 2013-2018 regional program, the Operating Board reassessed the drivers for the regional conservation program and set the goal, broad focus areas, and budget levels for the 2019-2028 regional conservation program.

The demand forecast continues to indicate that a new source of supply is not needed before 2060. This is due, in part, to reductions in per capita demand that offset the impact of population growth on total water use.

The Operating Board identified the following as the current drivers for conservation:

- Maintain a cushion between demand and supply,
- Ensure conservation capacity (staff expertise and industry partnerships) is available to deliver conservation services, as well as to respond to droughts and supply disruptions,
- Help customers use water wisely and manage their bills,
- Preserve the customer water conservation ethic,
- Be good stewards of our water resources and environment, and
- Meet regulatory, contractual, and stakeholder requirements and expectations.

The Saving Water Partnership's regional 2019-2028 Water Use Efficiency Goal is to:

**Keep the total average annual retail water use of
Saving Water Partnership members
under 110 mgd through 2028
despite forecasted population growth
by reducing per capita water use.**

This new regional goal has a higher threshold than the previous 2013-2018 goal. The increase from 105 mgd to 110 mgd reflects extension of the goal time period to cover the next 10 years, as well

inherent uncertainties in demand forecasting. The new goal still represents significant conservation within the context of continued population growth forecast for the 2019-2028 time period.

As with the previous goal, the new goal will capture all demand-side water savings from the conservation programs, codes and standards, and independent savings. Also, the 2019-2028 regional program will build on the strengths and successes of the 2013-2018 regional program; however, the focus areas will be modified slightly to reflect more recent priorities of the Operating Board. The 2019-2028 regional program will maintain the same total budget as the 2013-2018 program.

The specific program measures will be similar to the 2013-2018 program measures shown in Table 2-4, however the focus will shift slightly away from financial incentives and towards more education and technical assistance. The shift slightly away from financial incentives reflects the reality that the program has achieved considerable savings historically, the region does not need significant water savings from conservation in the near term, and plumbing codes and standards continue to contribute to savings. The shift towards more education relates to the objective of preserving the conservation ethic. First, existing customers require reinforcement of conservation messages in order to maintain their conservation ethic. Second, the significant influx of new people to the region means that additional efforts may be necessary to build up their conservation ethic. The cumulative savings for the regional program over the 10-year period is estimated to be 1.0 mgd.

SPU will also continue its low-income water conservation program for its retail customers.

2.4.1.2 Water Demand Forecast

Long-term water demand forecasting is critical for water system planning. SPU has updated and improved the Demand Forecast Model developed for the *2007 and 2013 Water System Plans*. This model incorporates the best features of various model types found in the applicable literature. Like simple “fixed flow factor” models, the new SPU model is easy to understand and has relatively modest data requirements. However, like more complex econometric models, the model reflects the impacts of variables such as price, income, and conservation on water use factors over time. This approach takes advantage of past econometric analyses to provide estimates of how price and income can affect demand. The model incorporates estimates of the impacts of passive savings on the water use factors over time, as described below. More

information on the model, data sources and assumptions is provided in an appendix.

SPU's official water demand forecast is presented in Figure 2-4 along with earlier forecasts. The various components that add up to the total demand forecast are shown in Figure 2-5. The demand forecast is slightly lower than the revised *2013 Water System Plan* forecast, and remains considerably below SPU's current firm yield of 172 mgd until well after 2060. Total demand is forecast to remain relatively flat through 2030 before rising gradually to a peak of 137 mgd in 2039. At that point, the Cascade block is scheduled to begin stepping down. Over the two decades that follow, water demand is forecast to decline as the annual 1 mgd reductions in Cascade's block more than offset what would otherwise be a modest amount of growth in demand. By 2060, total water demand from SPU's system is forecasted to have ramped back down to 133 mgd. Peak demands are also forecasted to remain below historic high levels.

Given the current firm yield estimate for SPU's existing supply resources, this forecast indicates that no new source of supply is needed before 2060.

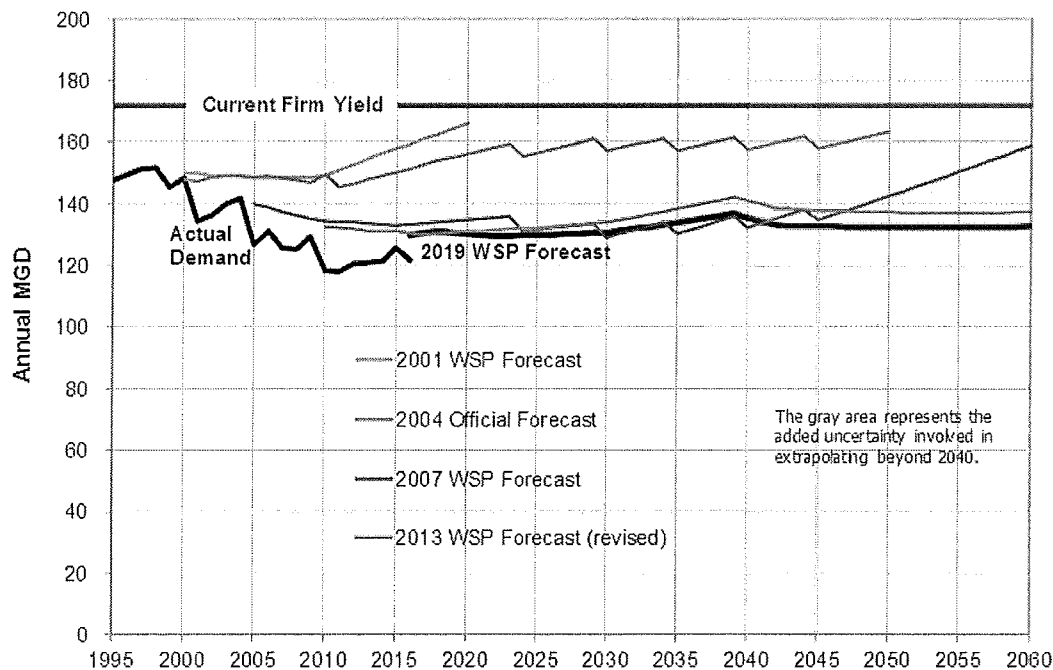


Figure 2-4. SPU's Official Water Demand Forecast

Note: Forecast demand is higher than actual demand in 2016 because the forecast includes all block contract amounts, whereas the actual demand by Cascade and Northshore has been less than their block contract amounts.

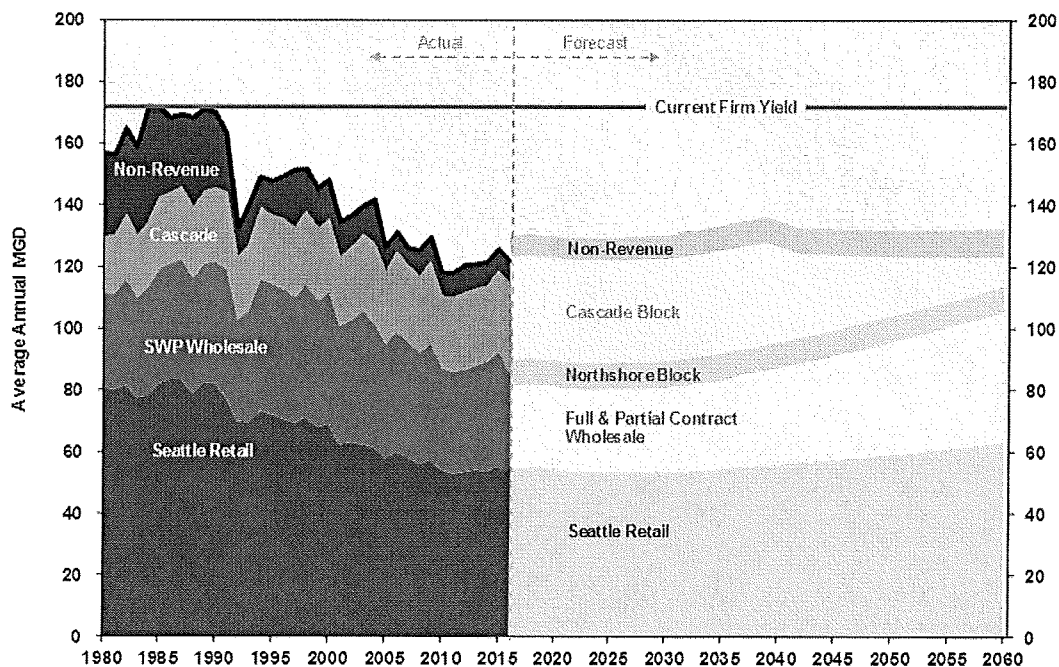


Figure 2-5. Components of Actual and Forecasted Demand

SPU's new official water demand forecast is based on a number of changes, particularly in the following key areas:

- **Future Conservation Goals and Programs.** The forecast includes the impact of the 2019-2028 Water Use Efficiency Goal and Program, described in the previous section.
- **Codes, Standards & Market Transformation.** The forecast includes reductions in water use due to codes, standards and market transformation. These include purchases of new plumbing fixtures and appliances that meet federal codes adopted in 1992, 2001, 2002, 2011 and 2015¹. The standards portion of savings in the forecast reflects the current proportion of fixtures and appliances sold in the market that exceed code, meeting the more stringent Energy Star, Water Sense, and Consortium for Energy Efficiency standards. Finally, market transformation refers to how those proportions are expected to continue shifting in the direction of higher efficiency over time.

¹ The US Department of Energy adopted a two-phase clothes washer efficiency standard in which the first phase was effective March 7, 2015, and the second, more stringent phase, will become effective January 1, 2018.

- Block Contracts. The block supply amounts to be provided by SPU to Northshore and Cascade are included in the forecast as stated in the contracts.
- Potential New Wholesale Customers. The demand forecast includes potential supply of 0.5 mgd to Ames Lake Water Association for meeting future needs in their service area.
- Non-Revenue Water. Combined transmission and Seattle distribution system non-revenue water is assumed to increase from 7 mgd in 2016 to 9 mgd by 2060. This increase is expected to be caused by the increasing number of leaks that are likely to occur as the distribution system ages.

Forecasting future water demand with certainty is impossible. The official water demand forecast is based on forecasts of income, water prices, households, and employment, all of which are subject to uncertainty. Additional uncertainty surrounds the forecast model's assumptions about price elasticity, income elasticity, and future conservation (the model assumes no programmatic conservation past 2028). These uncertainties were modeled by estimating probability distributions for each source of uncertainty. These distributions became inputs to an aggregate uncertainty model employing a Monte Carlo simulation¹ to characterize uncertainty associated with the official demand forecast.

The results of the Monte Carlo simulation are displayed in Figure 2-6. The green bands indicate the range of uncertainty associated with the official forecast. Each band represents a 10 percent increase (from the band immediately below it) in the probability that actual demand will be equal to or less than the level shown. For example, the bottom of the lowest band represents the 10th percentile, meaning that there is an estimated 10 percent chance that actual demand will be at or below that level (i.e., 107 mgd in 2060) and, thus, a 90 percent chance it will be above. The top of the uppermost band is the 90th percentile, corresponding to an estimated 90 percent probability that actual demand will be at or below that level (i.e., 163 mgd in 2060).

¹ A Monte Carlo simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distributions for the uncertain variables. The data generated from the simulation can be represented as probability distributions or confidence intervals. Because the method is based on random chance, it was named after the city of Monte Carlo which is known for its gambling.

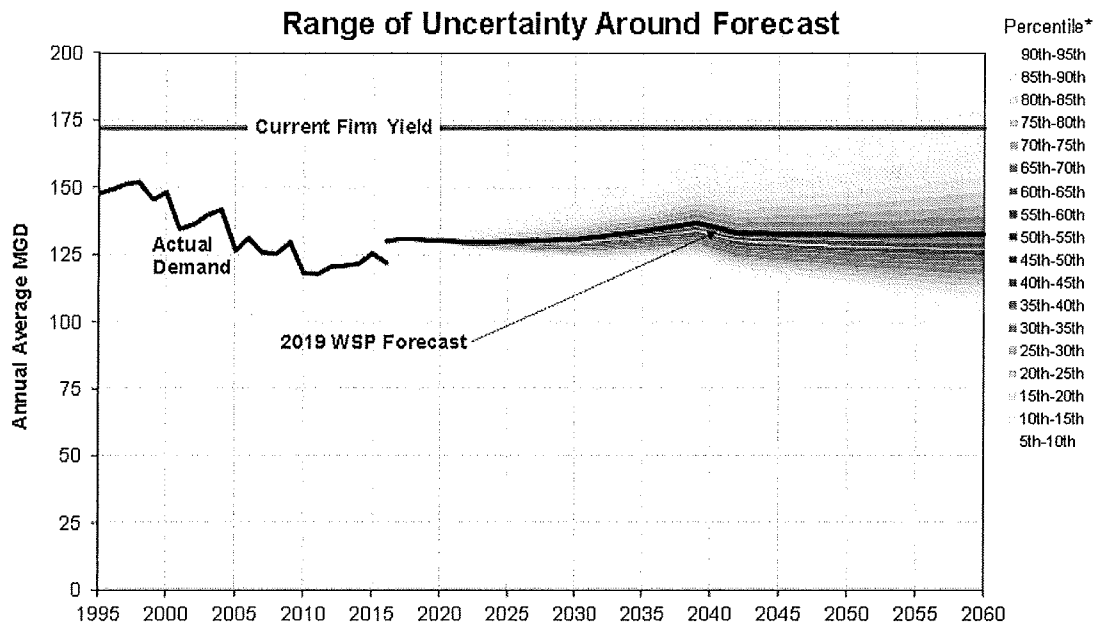


Figure 2-6. Uncertainty in Water Demand Forecast¹

This type of analysis provides insight into the uncertainty that surrounds the various inputs to the demand forecast model. It estimates a more than 90 percent probability that a new source will not be necessary before 2060 given the range of uncertainty in demand that was tested and current firm yield based on historic inflows.

SPU also considers the uncertainty of discrete events that produce significant and sometimes abrupt changes in customer demand. Assigning a probability of occurrence to these events is difficult. These uncertainties are examined through scenario planning in which the outcome of those events occurring is considered. For example, an increase in demand could occur if a wholesale customer's own source of supply is significantly less than forecasted and the wholesale customer chooses to have SPU provide for its additional needs. SPU monitors such developments so that adjustments to the forecast can be made when appropriate.

¹ Percentiles represent the probability that actual demand will be less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth, price elasticity, income elasticity, and conservation. Note that the official forecast is at about the 58th percentile.

2.4.1.3 Climate Change and Future Supply Outlook

Climate variability and climate change are uncertainties that SPU considers in ensuring that current and future water demands for people and fish are met. Climate variability and climate change are often used interchangeably, but for purposes of distinction, climate variability is used here to refer to a phenomenon that is cyclical in nature, while references to climate change denote persistent change that is largely human induced. Having managed the water supply system for more than 100 years, SPU is accustomed to providing adequate and reliable service in the face of climate variability.

Climate change is caused by an increase in heat-trapping atmospheric gases, known as greenhouse gases. Climate change can alter weather patterns and affect air temperatures, humidity, evaporation, cloud cover, rainfall, snowfall, snowpack, and runoff, in terms of averages, extremes, timing and distribution. The timing and magnitude of these changes and their effect on SPU's water supply and demand is uncertain but better understanding of the implications of climate change for SPU is a programmatic area of focus within SPU. SPU's policies for Supply Reliability and Planning for Uncertainty require that the potential impacts of long-term climate change on water supply and demand be addressed in developing supply investment strategies based on the most current knowledge and a wide range of climatic conditions.

The climate analysis reflected in this *Water System Plan* is a product of a collaborative research project between SPU and the Climate Impacts Research Consortium (CIRC), a NOAA-funded climate research group housed at Oregon State University. The research project was referred to as PUMA – Piloting Utility Modeling Applications. The PUMA project builds off of SPU's previous climate studies, the results of which were also reflected in previous water system plans. For the PUMA project, CIRC downscaled meteorological projections from the 20 different Global Climate Models (GCMs), paired with two Representative Concentration Pathways (RCPs), to several different point locations in the Central Puget Sound area. The resulting dataset was then used by SPU to create climate-altered streamflows and test the sensitivity of SPU's water supply under a range of plausible future conditions. For this *Water System Plan*, the analysis focuses on a 50-year time period from 2000 to 2050 using RCP 8.5, which is the scenario with the greatest concentration of greenhouse gases.

The ensemble of future climate projections shows an increasing trend in average temperatures across all seasons (Figure 2-7). Warmer winter temperatures would result in more precipitation falling as rain and less as snow, resulting in declining snowpack over time. While projections show little to no trend in average annual precipitation, several models suggest an amplification of current seasonal patterns; winter precipitation may increase and summer precipitation may decrease in the future. The variability in annual precipitation is expected to increase in the future, which would result in drier and wetter years than have been observed historically. The potential for anomalously dry winters in combination with warmer winter temperatures in the future creates the possibility that there will be years in the future that SPU is unable to meet reservoir refill targets in the spring.

The regional average annual streamflow hydrograph is characterized by two peaks. The first peak occurs in the late fall when the rainy season begins. Flows are reduced as temperatures cool and a greater portion of precipitation falls as snow which accumulates as snowpack. The second hydrograph peak occurs in the spring as temperatures rise and snowmelt runs off to the stream. It is important to note that any given year will look different than the generalized average hydrograph because of variability in weather patterns from year to year.

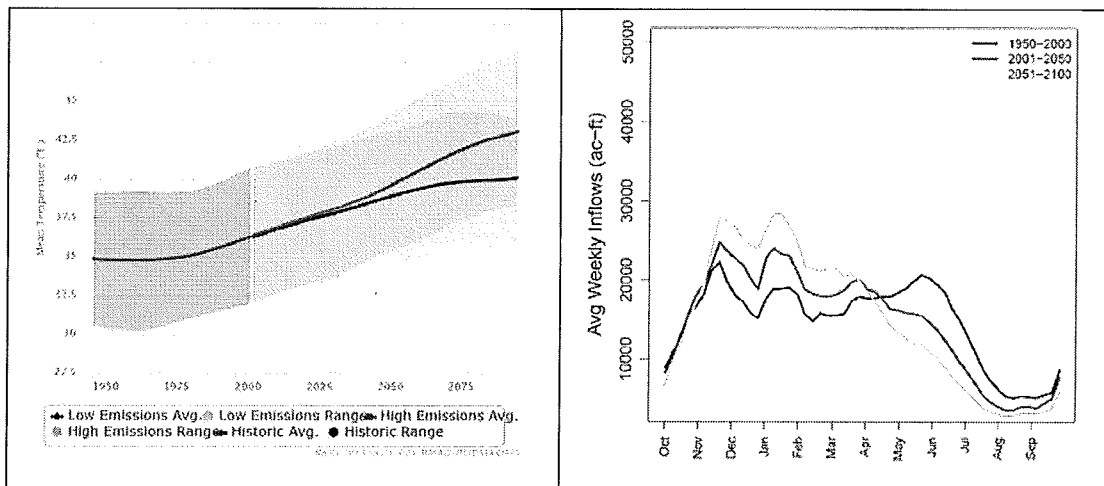


Figure 2-7. Air Temperatures and Streamflows Under Climate Change Scenarios¹

¹ Left-hand graph: Historic average temperatures (in grey) and projections of future temperatures under two emissions scenarios through 2100. Right-hand graph: Total average weekly inflow supply as calculated by 20 GCMs for three time periods.

Seattle's watersheds are more sensitive to warming temperatures than other mountain watersheds due to their maritime geography. In a single storm event, it is common that precipitation falling at higher elevations is snow while rain falls at the lower elevations. Increased temperatures without a change in total amount of annual precipitation would result in similar total annual streamflow to what has occurred historically, but with a shift in the seasonality of peak inflows. On average, in the future more precipitation will fall as rain instead of snow in the winter leading to increased winter flows, less snowpack accumulation, and earlier snowmelt driven flows in the spring. In the most severe scenarios, winter temperatures may be sufficiently warm to eliminate the snowpack altogether resulting in a single winter peak in the hydrograph (Figure 2-7). Forecasted declines in summer precipitation would result in lower summer flows.

The future climate scenarios suggest that the primary impact of climate change on flow regime will be more frequent temperature-driven droughts due to low snowpack and/or early snowmelt which generally leads to an extended summer dry season. Increased variability in precipitation could lead to more severe conditions in extreme years when the temperature-driven drought conditions are combined with low winter precipitation or later return of fall rains than has been observed historically.

A shift in seasonality of the annual streamflow hydrographs would effectively extend the reservoir drawdown season with more of the annual inflow occurring during flood season, when excess water is released from the reservoirs to keep reservoir water levels lower for flood management purposes, and less flow occurring in the spring when the reservoirs are typically refilled. The extended drawdown season will result in a greater draw from storage, which could be further exacerbated by decreased summer flows and potential increases in water use by customers due to hotter, drier summer weather.

Recent analysis shows that SPU's water supply system will be increasingly vulnerable to the seasonal hydrologic shifts associated with climate change. Hydrologic vulnerabilities are identified for each of the 20 GCM scenarios analyzed by comparing average historical inflows to a GCM's individual year from the near future (2000-2050) in which SPU is unable to meet water demands for people and fish. In 14 of the scenarios indicative of increased vulnerability, total spring inflows (April- June) are outside of the historic range of inflow variability, and 17 of these scenarios have summer flows (July-September) that are less than the historic average. The combination of low spring flows and below average

summer flows occur in 13 of the 20 scenarios that indicate an increasing system vulnerability. The table below shows the adaptation strategies that can be used with the existing system to address one or more of these vulnerabilities.

Table 2-5. Potential Adaptation Strategies to Address Climate Change Vulnerabilities

Vulnerability	Adaptation Strategies
Low snowpack and spring flows	• Early reservoir refill • Higher reservoir refill
Low summer flows	• Lower reservoir drawdown
Low spring and summer flows	• Early reservoir refill • Higher reservoir refill • Lower reservoir drawdown • Optimize use of reservoir storage

There are several ways to implement these adaptation strategies by operating the existing system differently. Many of these adaptations have been partially implemented in the past to help get through the toughest historic years. These potential operational changes include:

Early Reservoir Refill

- **Dynamic Reservoir Management:** Store more water in the reservoirs when snowpack and soil moisture conditions in the Cedar and Tolt watersheds indicate flood risks are lower than normal and supply conditions would likely be poor. This practice has been used since the mid-1990's and shown to be successful.
- **Early Refill (prior to June 1st) and Dynamic Reservoir Management:** Begin refill earlier based on estimates of snowpack and soil moisture conditions in the Cedar and Tolt watersheds.

Higher Reservoir Refill

- **Higher Refill of Chester Morse Lake:** Refill to elevation 1566 feet, 3 feet above historic maximum fill, adding 11 percent more storage in the Cedar system without new infrastructure or changes to water rights. Further analysis is needed to determine the cost and feasibility of this option, including the impacts of the higher refill level on tributary fish habitat, forest inundation, road impacts, flood management, moraine seepage and dam safety.
- **Higher Refill of Chester Morse Lake and Overflow Dike Improvements:** Optimize higher refill by modifying the

Overflow Dike to include a maximum elevation of 1554 feet to better manage seepage losses. Further analysis is needed to determine if a replacement for the flashboards would be beneficial and to assess potential environmental impacts of higher pool levels during the pool split period.

Lower Reservoir Drawdown

- Cedar Drawdown: Access storage in Chester Morse Lake below elevation 1538 feet more frequently using Morse Lake Pump Plant.
- South Fork Tolt Reservoir Drawdown (modest): Draw an additional 20 feet to elevation 1690 feet, adding 18 percent more storage in the Tolt system without new infrastructure or changes to water rights.
- Lake Youngs Drawdown (modest): Use 5 feet of storage in Lake Youngs to meet water demands.

Optimize Use of Reservoir Storage

- Tolt/Cedar Transfer Capacity: Improve ability to deliver Tolt water south to what would otherwise be served by the Cedar system to maximize the use of combined system storage.

While the operational changes listed above can partially mitigate the potential impacts of climate change on water supply availability, initial analysis suggests that even with these operational adaptations the system faces increasing vulnerability by the end of the century, primarily due to warmer temperatures extending the summer dry period. More severe vulnerabilities could be caused by the increased variability in precipitation combined with rising temperatures. These increased vulnerabilities may lead SPU to construct new supplies, as described below in Section 2.4.1.4, which will require significant investments. There is a large degree of uncertainty in the timing and magnitude of climate impacts on supply vulnerability, but the trend and range of potential outcomes indicate that planning for increased system resiliency should remain a top priority in coming years.

The above analysis does not assess the effect of climate change on several key factors that influence water supply, water demands, watershed resources, and supply operations. For example, climate change impacts on water quality, particularly the frequency of high turbidity events and algal blooms that can be disruptive to supply operations, have not been evaluated but can reduce supply availability. Impacts from more frequent and severe high flow

events on properties downstream of reservoirs and instream resources (i.e. redd scour) have not been evaluated. These issues are a sampling of topics SPU intends to explore as part of its sustained engagement with the research community and professional organizations.

Moving forward, SPU will pursue the following:

- Actively manage reservoirs based on real-time watershed conditions and weather forecasts.
- Install additional monitoring soil moisture monitors and high elevation temperature monitoring stations to improve watershed moisture tracking (soil) and high elevation temperature to support dynamic reservoir management.
- Update the analysis of the adaptation options to include considerations of cost, environmental impacts, policy implications, in addition to gains in water supply.
- Continue tests to monitor and assess environmental and dam safety considerations associated with routinely refilling Chester Morse Lake to 1566 feet.
- Identify and plan for additional adaptation and new supply options with an emphasis on building system resilience under a range of potential scenarios.
- Identify indicators that can be tracked and used to help determine when to pursue more complex and expensive adaptation or new supply options.
- Continue developing and fostering collaborative partnerships with academic researchers and professional organizations in order to obtain actionable science¹ that SPU can use to enhance our knowledge base, build institutional capacity and inform planning for future climate change.

Given the dynamic nature of climate research, SPU is committed to remaining engaged in future research, conducting new assessments on a periodic basis to identify potential impacts and system vulnerabilities, and planning for adequate water supply

¹ The following is a definition for actionable science developed by the U.S. Department of Interior's Advisory Committee on Climate Change and Natural Resources Science. "Actionable science provides data, analyses, projections, or tools that can support decisions regarding the management of the risks and impacts of climate change. It is ideally co-produced by scientists and decision makers and creates rigorous and accessible products to meet the needs of stakeholders."

while ensuring that decisions do not result in unnecessary or premature financial and environmental costs for the region.

2.4.1.4 Future Supply Opportunities

While the firm yield update indicates that no new supply is needed well into this century to meet forecasted demand, the climate change analysis indicates that SPU may need to construct new sources of supply to address increasing vulnerabilities. The supply alternatives identified in previous water system plans remain as opportunities for SPU to consider, as well as additional alternatives, should key triggers indicate the need to develop a new supply source. The new supply alternatives include:

- Permanent Cedar Drawdown: Access storage in Chester Morse Lake below elevation 1538 feet for normal supply using Morse Lake Pump Plant.
- South Fork Tolt Reservoir Drawdown (aggressive): Draw an additional 50 feet to elevation 1660 feet, the lowest intake level, which may require changes at the Tolt Water Treatment Facility.
- Lake Youngs Drawdown (aggressive): Use 28 feet of storage in Lake Youngs to access to an additional 17,390 acre-feet, which will likely require the addition of filtration at the water treatment facilities.
- North Fork Tolt River Diversion: Construct a small diversion on the North Fork Tolt in addition to drawdown of the South Fork Tolt to elevation 1660 feet.
- Snoqualmie Aquifer: Development of the Snoqualmie Aquifer with new river intake, filtration plant, pump station, and an interconnection to SPU's Tolt pipeline.
- Cedar High Dam: Construct a new and higher dam at the current Overflow Dike location.
- Desalination: Construct a desalination plant to use saltwater pumped from Puget Sound.
- Reclaimed Water: Develop one or more reclaimed water projects to reuse wastewater.
- Distributed Systems: Construct multiple, small systems throughout the service area to offset potable water use, such as greywater and rainwater harvesting systems.
- Regional Interties: Construct interties with adjacent regional water suppliers to access water from those sources.

2.4.1.5 Wildfire Risk Management in SPU's Watersheds

SPU acknowledges that a large wildfire in its drinking water supply watersheds could pose a threat to the primary mission of providing high quality drinking water supply as well as to aquatic and terrestrial habitats for fish and wildlife species. Current policy is to aggressively prevent and suppress all wildfires to address this risk. Prevention includes controlling watershed access and restricting activities, while suppression includes initial attack on wildfire starts and support to the Washington Department of Natural Resources, who ultimately is responsible for wildland fire suppression throughout the state.

SPU has conducted substantial work to assess the fire hazard, potential changes in key indicators of changing fire behavior, and benchmarking with other land managers on best practices to manage wildfire risk. The intent of these studies was to understand effect of watershed management on fire hazard, assess potential mitigation strategies to reduce fire hazard, identify gaps in wildfire risk management and prioritize potential actions. The most recent risk assessment indicates that SPU is well situated with respect to fire prevention and suppression strategies relative to similar land managers and water utilities.

Forests in the Cedar and Tolt River Municipal Watersheds are moist west-side forests that are characterized by low frequency fires (every 200 years or so), in contrast to the historically high frequency (every 15 years or so), low severity wildfire of drier forest types on the east side of the Cascades Crest. Forest and fire ecologists point out that ultimately, at some time and place, suppression on the west-side will fail, driven largely by extreme fire weather. Large fires with high severity are characteristic of these west-side forest types, and they may have catastrophic impacts to drinking water supply and ecosystems. Climate science projects increases in fire frequency and area burned along with ecosystem changes. SPU is investigating climate adaptation strategies to increase resilience in its water supply watersheds to reduce the future risk of catastrophic wildfire in the face of potential effects of climate change.

2.4.2 Infrastructure Needs and Improvements

SPU maintains its water resources facilities for safe and reliable operation to ensure water supply is available for its customers. Several studies and infrastructure improvement projects have been identified to improve the reliability and flexibility of the existing

water supply system. These projects and studies are described below.

2.4.2.1 Landsburg Flood Passage Improvements

Since the Cedar River flooded in fall 1990, there have been concerns about flood debris, such as large trees uprooted during high flows, blocking the spillway gates at Landsburg Diversion Dam during major floods. SPU is conducting new studies of large woody debris management in the Cedar River and riparian zone. This information will be used to update the evaluation of flood passage at the Landsburg Diversion Dam, which will also consider potential increases in the number of flood events, duration of high flows and more peak flow events due to climate change. SPU will also conduct preliminary engineering and life-cycle cost analyses of options to improve the flood passage capabilities at the dam and reduce the risk of overtopping of the dam during large flood events, which could potentially cause severe erosion of the embankments and place the dam at risk of failure and impede the delivery of water.

2.4.2.2 Lake Youngs Cascades Dam

Water stored in Lake Youngs is impounded by two earth embankments, the Outlet Dam to the south and Cascades Dam to the east, and the perimeter dikes around the lake. A third dam, Inlet Dam, east of Cascades Dam, normally does not store water and was constructed as a backup embankment to retain the reservoir water in case of a failure of Cascades Dam, which shows signs of movement and is considered to be somewhat unstable. As noted previously, SPU plans to conduct further investigations and studies to determine the potential impact on water quality that could be caused by failure of Cascades Dam, particularly with respect to material existing in the area between Cascades Dam and the Inlet Dam.

2.4.2.3 Tolt Valve 15

A leak in the South Fork Tolt Valve 15, which helps control the Tolt reservoir's water level, is interfering with SPU's ability to monitor other leaks through the Dam Spillway Conduit. Monitoring these conduit leaks is the principal means for tracking the stability of the dam's earthen fill. The Federal Energy Regulatory Commission (FERC) has directed SPU to eliminate the leakage through Valve 15 as soon as possible. Design work started in August 2017 with a planned valve replacement in the summer of 2018.

2.4.2.4 Tolt Dam Warning System

The South Fork Tolt Dam early warning and performance monitoring systems include numerous components that have reached their end of life and/or no longer have manufacturer support, individual components cannot be separately upgraded to meet current system needs. These systems are part of the Emergency Action Plan (EAP) that SPU and SCL jointly maintain every year and is required by FERC. Design work on replacing the system started in 2017 and with the goal of finishing construction in 2019.

2.4.2.7 Tolt Dam Log Boom

The South Fork Tolt Dam log boom is reaching the end of life and needs to be replaced. The log boom was constructed in 1998 during the Intake Tower seismic upgrade. The log boom consists of a series of clustered plastic logs connected with chain links. Each cluster consists of five plastic logs bundled together and a debris screen fixed on underside of the logs. Replacement of the log boom is planned around 2021.

2.4.3 South Fork Tolt FERC Relicensing Support

The Federal Energy Regulatory Commission (FERC) issued Seattle City Light (SCL) a license to operate the hydropower project at the South Fork Tolt Dam in 1984. The FERC license led to an agreement that established, among other things, requirements for minimum instream flows that impact SPU's water supply operations. The current license expires in 2029, and relicensing a hydropower project using the default licensing process (Integrated Licensing Process) typically takes about five years. SCL will lead the relicensing process in collaboration with SPU. The relicensing process allows stakeholders an opportunity to identify potential issues which could result in studies requiring SPU support. It is not known at this time whether the new license will lead to changes in water supply operations or additional obligations for SPU.

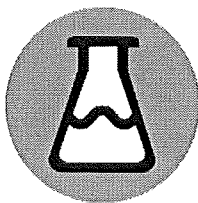
2.5 IMPLEMENTATION/ACTION PLAN

In the absence of a need to develop new water supplies for several decades, SPU's implementation/action plans in the Water Resources business area will focus on continuing conservation efforts, pursuing additional work to assess climate change impacts, and completing infrastructure upgrades to water supply facilities.

A summary of the implementation/action plan for the Water Resources business area is as follows:

- Keep the total average annual retail water use of Saving Water Partnership members under 110 mgd through 2028 despite forecasted population growth by reducing per capita water use.
- Continue to implement water conservation efforts that help low-income customers in Seattle manage their water bills.
- Pursue the actions identified to address potential climate change impacts on water supply, including:
 - Update the analysis of the adaptation options to include considerations of cost, environmental impacts, policy implications, in addition to gains in water supply.
 - Continue tests to monitor and assess environmental and dam safety considerations associated with routinely refilling Chester Morse Lake to 1566 feet.
 - Investigate raising the Overflow Dike to elevation 1554 feet.
 - Identify and plan for additional adaptation and new supply options with an emphasis on building system resilience under a range of potential scenarios.
 - Identify indicators that can be tracked and used to help determine when to pursue more complex and expensive adaptation or new supply options.
- Continue developing and fostering collaborative partnerships with academic researchers and professional organizations in order to obtain actionable science that SPU can use to enhance our knowledge base, build institutional capacity and inform planning for future climate change.
- Investigate climate adaptation strategies to increase resilience in the water supply watersheds to reduce the risk of changing disturbance patterns, such as extreme precipitation events, extended droughts and large wildfires that could impact forest and stream habitats, water quality and water supply.
- Conduct studies and complete infrastructure improvements to water supply facilities:
 - Complete options analysis to improve the flood passage capabilities of the Landsburg Dam and implement

- recommendations to reduce the risk of overtopping during large flood events.
- Complete investigations to determine the potential impact on water quality that could be caused by failure of Lake Youngs Cascades Dam and potential improvements to mitigate this risk.
- Complete work on South Fork Tolt Valve 15.
- Replace the Tolt Dam Warning System.
- Replace the South Fork Tolt Dam log boom.
- Support Seattle City Light in studies need for FERC relicensing of the South Fork Tolt Hydroelectric Project.



CHAPTER 3

WATER QUALITY AND TREATMENT

This chapter of the *2019 Water System Plan* focuses on the Water Quality and Treatment Business Area, which administers SPU's drinking water quality and treatment programs, projects, services, and capital assets from the supply source to the customers' taps. Key functions of this business area include managing SPU's drinking water regulatory compliance, implementation of the cross-connection control program, oversight of the Tolt and Cedar Water Treatment Facilities and their contract operations, ensuring appropriate monitoring of water quality for regulatory and operational purposes, managing distribution system water quality, overseeing water quality and treatment related capital improvement projects, and participating in other water system projects that have the potential to impact water quality. The Water Quality and Treatment business area is unlike other business areas in that its programs affect infrastructure and practices in the Major Watersheds, Water Resources, and Transmission and Distribution business areas. This chapter also includes descriptions of the drinking water regulatory requirements SPU must meet or exceed, as well as SPU's history of compliance.

SPU's water system includes two water treatment facilities for the Cedar and Tolt source waters that provide high levels of treatment prior to transmission and distribution.

3.1 ACCOMPLISHMENTS SINCE 2013 WSP

Since completion of the *2013 Water System Plan*, SPU has implemented the following major improvements in the Water Quality and Treatment business area:

- **Laboratory Information Management System (LIMS):** Updated LIMS to version 10 at SPU's Water Quality Laboratory in 2015 to ensure continued vendor support and improved reporting capability.
- **Security:** Enhanced physical security improvements at the Tolt facility.
- **Service Agreements:** Amended service agreements for the Cedar and Tolt Water Treatment Facilities.
- **Cross-Connection Control Program:** Upgraded the software system used for tracking compliance of backflow assembly testing required by the Cross-Connection Control Program.
- **Landsburg facility:** Converted from gas chlorination to hypochlorite at the Landsburg facility to improve safety.

- **Lake Youngs Supply Line Standpipes:** Extended the elevation of the standpipes to reduce risk of overflow when bypassing Lake Youngs.
- **Reservoir Covering/Burying:** Disconnected the remaining open reservoirs, Roosevelt and Volunteer, from the water system, while continuing to evaluate their future use for emergency supply and/or potable supply.
- **Eastside Reservoir:** Sealed the roof to wall joint and improved drainage off the reservoir roof to prevent runoff and seepage from entering the reservoir.
- **Coliform Sampling:** Increased number of coliform sampling by thirty percent; added sampling stations in multiple pressure zones.
- **Fluoride:** Reduced fluoride treatment target to 0.7 mg/L in accordance with new federal guidelines and new state regulations.

3.2 SERVICE LEVEL PERFORMANCE

SPU's service level in the Water Quality and Treatment business area focuses on meeting federal and state regulatory requirements. This is captured in a single service level objective and target for drinking water quality as shown in Table 3-1.

Table 3-1. SPU's Service Level for Managing Water Quality and Treatment Assets

Service Level Objective	Service Level Target
Promote a high level of public health protection and customer satisfaction with drinking water quality.	Meet all health-related and aesthetic regulations administered by the WDOH Drinking Water Program for the Seattle regional water system.

SPU's service level target is to meet health-related regulations (i.e., primary maximum contaminant levels and treatment requirements), aesthetic regulations (i.e., secondary maximum contaminant levels), and other aesthetic criteria (i.e., taste, and odor). SPU has been successful in meeting this service level with the exception of a treatment technique violation and one missed sample at the Tolt Treatment Facility as explained below. SPU has a Reservoir Covering Plan approved by Washington State Department of Health (WDOH) that was completed ahead of schedule (see Section 3.3.6.1). More information on how SPU is meeting regulations is provided in the remainder of this chapter.

3.3 EXISTING FACILITIES AND PRACTICES

SPU's water system includes drinking water treatment facilities for the Cedar and South Fork Tolt source waters, treatment and intake screening facilities at Landsburg, intake screening facilities at the Tolt Regulating Basin, and in-town disinfection facilities at reservoirs and well sites. Each of these facilities is operated and maintained to ensure that the potable water SPU delivers to its customers meets high public health and aesthetic standards.

To achieve its water quality and treatment service level, SPU has expended a great deal of effort over the past decades and continues to make concerted efforts to ensure compliance with WDOH drinking water regulations. SPU operates its facilities, monitors water quality at those facilities, and engages in a number of practices designed to bring safe, high-quality drinking water to its customers. This section summarizes SPU's record of regulatory compliance, identifies SPU's treatment facilities, and summarizes its operation and maintenance practices to ensure excellent water quality and a high level of customer satisfaction.

3.3.1 Regulatory Requirements and Compliance

Federal and state statutes and administrative regulations require the utility to meet certain water quality criteria and performance standards. The following subsections identify the standards and requirements that SPU must achieve and summarize SPU's performance in meeting those standards and requirements.

3.3.1.1 Total Coliform Rule

The Total Coliform Rule (TCR) requires monitoring to demonstrate that a water system is operating and maintaining its distribution system in a way that minimizes the risk of bacterial intrusion or regrowth. SPU collects required monthly samples from its retail service area distribution system and tests for coliforms, which are naturally present in the environment and are used as an indicator of whether other, potentially harmful, bacteria may be present. As system improvements, especially better disinfection facilities and covered reservoirs, have been implemented, SPU's success in meeting the total coliform rule requirements have improved greatly.

As indicated by Figure 3-1, below, SPU has been continuously in compliance with the TCR. Since the startup of the Cedar Water Treatment Facility in August 2004, SPU has been well within the regulatory requirement of less than 5 percent of samples with

detectable total coliform for its distribution system. For the past 10 years, the highest percent positive occurred in July 2008, at 2.1 percent.

Over the past 10 years, there have been almost 30,000 coliform samples collected. Of those 30,000 distribution samples, 35 have been positive for total coliform, and two have been positive for *E. Coli*. (both in 2010). All follow-up sampling for the *E. Coli* positive samples showed no indication of contamination, and compliance with the TCR was met. Public notification was not required.

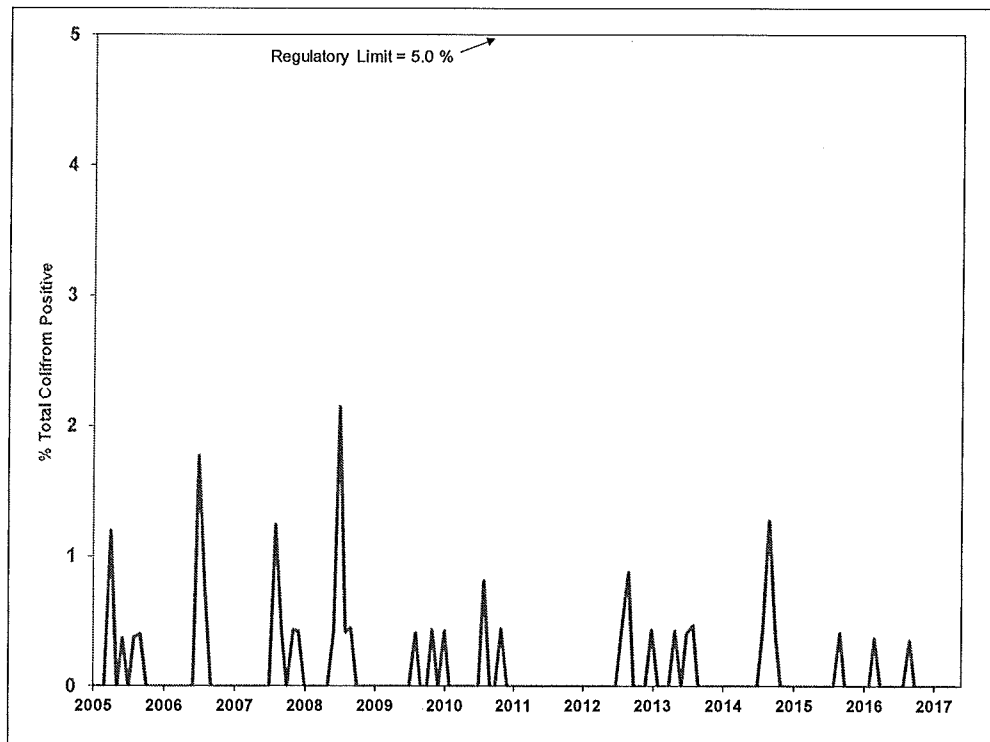


Figure 3-1. Monthly Coliform Data from SPU's Distribution System

In addition, 10 new sampling locations have been installed within the distribution system. All 10 locations represent small pressure zones or areas not covered by the existing sites. The total number of TCR sampling sites in the distribution system is now 73, which covers over 99 percent of the service connections.

Also, new since the previous *Water System Plan* is the Revised Total Coliform Rule, now in effect. The new rule should not have any major impacts to SPU's TCR program, but would require a Level 1 assessment if more than 5 percent of the samples are positive for total coliform in a month, or repeat samples are not collected as required. A Level 2 assessment would be required if

an *E. Coli* MCL violation occurs, or if a second Level 1 assessment is triggered within a rolling 12-month period. The triggers for Level 1 and Level 2 assessments have not occurred in the SPU distribution system since the new treatment plants for the Cedar and Tolt supplies came on-line.

3.3.1.2 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) contains disinfection and filtration requirements for all public water systems that use surface water supplies. Several revisions to the original rule have been made since 1989, with the latest revision being the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

Tolt Supply. Since completion of the Tolt Treatment Facility in 2001, the supply from South Fork Tolt River has been required to meet all the regulatory treatment standards for a surface supply using filtration and disinfection. The Tolt Treatment Facility operations contract includes water quality performance requirements that meet and, in most cases, exceed the regulatory filtration and disinfection requirements. Since startup, the Tolt Water Treatment Facility has had one treatment technique violation (17 minutes of elevated turbidity in 2015) and one minor monitoring violation (one missed bromate sample in 2016); neither situation presented a risk to public health.

Cedar Supply. Construction of the Cedar Water Treatment Facility was completed in 2004. The Cedar River supply has a regulatory designation known as a “Limited Alternative to Filtration” (LAF), which authorizes SPU to operate the Cedar source without filtration treatment. LAF status is granted because Cedar source water is produced from a watershed that is in public ownership and control, with no residential, commercial or industrial development, and the treatment system employs a multi-stage disinfection process that provides greater protection against microbial contamination than can be provided by traditional filtration and chlorine disinfection. The Cedar supply continues to operate in compliance with the LAF criteria and is the only system in the country with this regulatory designation.

Like the Tolt Water Treatment Facility, the Cedar Water Treatment Facility operations contract includes water quality performance requirements that meet and, in most cases, exceed regulatory requirements. Since it began operating in 2004, the Cedar Water Treatment Facility has experienced no treatment violations.

Long Term 2 Enhanced Surface Water Treatment Rule. The LT2SWTR, focuses on controlling *Giardia* and *Cryptosporidium* in surface water supplies. This rule affects the Seattle water system in two ways: source monitoring for *Cryptosporidium* and covering of open distribution reservoirs. The second round of source monitoring for *Cryptosporidium* was completed in March 2017. The results for both the Cedar and Tolt were in the lowest category (highest quality), so no changes are needed to the existing treatment provided.

The LT2ESWTR also requires that open, treated-water reservoirs be covered or provided with treatment on the outlet. The last open reservoir in Seattle was taken out of service in 2013.

3.3.1.3 Groundwater Rule

The Groundwater Rule was issued in November of 2006 and went into effect in 2009. SPU uses its wells for production purposes as a seasonal source dependent on supply conditions and system demand. SPU last used its wells for production in 2015. SPU's wells draw from a deep aquifer that is well protected from contamination. When the Seattle Wells are next used, SPU's plan for compliance is to conduct triggered source water monitoring as necessary. While not part of the current regulatory compliance strategy, chlorine contact time for disinfection of viruses is achieved in the pipelines a short distance from the wells.

3.3.1.4 Disinfection By-Products Rule

In general, SPU's high quality source water and upgraded treatment result in low concentrations of disinfection by-products (DBPs), such as trihalomethanes (TTHMs) and haloacetic acids (HAAs), by-products that can result from reactions between chlorine and natural organic matter. Trihalomethane and haloacetic acid monitoring results for the distribution system since the Stage 2 Disinfectant/Disinfection By-Products Rule went into effect in 2012 are shown in Table 3-2, below.

Compliance with the Stage 2 DBP Rule is now based on a Locational Running Annual Average (LRAA), instead of a system wide average. The LRAA calculated each quarter for each sampling location must be below the MCLs for HAAs and TTHMs. The MCLs are 60 ug/L for HAAs, and 80 ug/L for TTHMs. The table below shows that the highest LRAA for HAAs was 48 ug/L, and the highest LRAA for TTHMs was 62 ug/L, both well below the MCLs.

Table 3-2. Disinfection By-Product Levels under the Stage 2 DBP Rule (since 2012)

Site	Typical Source	HAAs, LRAA, ug/L			TTHMs, LRAA, ug/L		
		Minimum	Maximum	Average	Minimum	Maximum	Average
A-2	Tolt	31	44	37	26	41	32
A-3	Tolt	32	40	36	25	38	31
A-4	Tolt	26	41	31	28	42	33
B-3	Tolt	32	48	37	25	48	33
B-4	Tolt	27	42	34	29	62	41
C-5	Tolt	30	42	35	26	41	30
D-1	Cedar	28	37	32	22	36	30
D-2	Cedar	23	33	27	29	40	34
E-2A	Cedar	23	34	29	21	31	26
F-4	Tolt	30	40	34	25	41	31
G-1	Cedar	34	44	38	27	36	31
G-2	Cedar	18	33	22	28	37	33
Average				33			32

The SPU distribution system easily meets the MCLs a majority of the time, but occasionally has high results during by-passing of Lake Youngs, or when the Tolt Reservoir is drawn down low (followed by a large rain event). These events usually only affect results for 1 quarter, and SPU can help mitigate the impacts by switching supplies if needed.

3.3.1.5 Lead and Copper Rule

SPU's source and distribution water contains no significant amounts of lead or copper. Household plumbing, however, is often made of copper, and household systems can include components containing lead, such as lead-tin solder and leaded-brass fixtures. These components can leach lead and copper into the water. SPU reduces the risk of potential lead and copper leaching by continuously treating its source water to specific optimized corrosion control targets for pH and alkalinity.

The SPU Regional Lead and Copper Monitoring Program was divided into four sub-regions in 2005. Compliance for Seattle has been based on samples collected from the SPU's direct service area only since 2005. Compliance for the other sub-regions (Bellevue, Tolt Wholesale, and Cedar Wholesale) is based on results from those sub-regions.

The Lead and Copper Rule requirement is to be below 15 ug/L for lead, and below 1,300 ug/L for copper, with both at the 90th

percentile. Seattle's 90th percentile lead levels for the last two rounds of monitoring (2013 and 2016) were 3.0 and 3.1 ug/L, well below the lead action level. For copper, Seattle's 90th percentile levels for the two most recent rounds were 104 and 146 ug/L. These levels have allowed Seattle to conduct reduced monitoring for lead and copper. Fifty samples are now collected once every three years from qualified homes in the SPU direct service area. The next sampling period for the SPU sub-region will occur in 2019.

Because compliance for this rule is based on a regional program, SPU also tracks the 90th percentile levels for the other sub-regions. The lead 90th percentile for the last 6 years has been below 5.0 ug/L for all sampling rounds and sub-regions. The copper 90th percentile has also been well below the action level, generally less than 200 ug/L for each sampling round.

Compliance for the Lead and Copper Rule is also determined by Water Quality Parameter monitoring. This monitoring demonstrates optimized corrosion control treatment. SPU must maintain finished water pH and alkalinity within ranges set by DOH. The target pH for water leaving the Cedar and Tolt Treatment Facilities is 8.2, with a minimum of 7.9. The target alkalinity level for water leaving the Tolt Treatment Facility is 19 mg/L, with a minimum of 15 mg/L. The Cedar system does not have an alkalinity target. The minimum pH for the distribution system is 7.6, while the minimum alkalinity for the distribution system is 15 mg/L.

Compliance for the treatment plants is based on a calculated daily average. Compliance for the distribution system is based on monitoring at 10 locations distributed throughout the regional system, and currently occurs on a quarterly basis. This frequency is considered reduced monitoring. SPU qualifies for reduced monitoring by having maintained optimal corrosion control treatment for at least three consecutive years. Water Quality Parameters cannot be outside the ranges set by the state for more than nine days in any 6-month monitoring period. SPU has met this requirement since optimized corrosion control treatment was fully implemented in 2003.

3.3.2 Other Water Quality Monitoring

SPU conducts a range of other regulatory and non-regulatory water quality monitoring throughout the water system.

Source Monitoring. SPU conducts source monitoring for hundreds of potential contaminants, including inorganic chemicals, volatile organic chemicals, synthetic organic chemicals, and radionuclides. None of the SPU water sources have had chemical concentrations near the compliance limits for any of these contaminants.

Closed Storage Monitoring. Throughout the year, SPU monitors the quality of water within covered storage facilities as part of its routine water quality monitoring program. The information guides system operations, reservoir turnover, spot disinfection, and decisions about when to take facilities out of service for cleaning or other actions. Covered storage facilities are typically sampled bi-weekly for chlorine residual and microbial parameters. Closed storage with booster chlorination are equipped with online chlorine analyzers.

Taste and Odor Sampling. Taste and odor testing is conducted bi-weekly by a trained flavor profile analysis panel at SPU. The testing monitors and characterizes changes in tastes and odors associated with the source waters and water leaving the treatment plants. These test data are used to ensure source treatment performance criteria are met.

Emerging Contaminants. Emerging contaminants are not regulated, they are generally new to drinking water scientists, and there is typically limited information about their occurrence and health effects. EPA requires water systems to perform monitoring for some of these contaminants in order to learn about their occurrence. In addition, SPU has chosen to test for other emerging contaminants for its own information and to inform the public. Details of this monitoring are described later in this chapter.

Miscellaneous Monitoring. SPU also conducts extensive water quality monitoring at the Landsburg Diversion on the Cedar River, Chester Morse Lake, Lake Youngs, the Tolt Reservoir, and the Tolt Regulating Basin. Nutrients, algae, and other basic chemical and physical parameters such as pH, temperature, total organic carbon, ultraviolet absorbance, dissolved oxygen, reservoir stratification, and visibility throughout the water column are monitored. This water quality information is used to better understand the conditions in the water bodies, to learn about potential shifts or changes with significance to the drinking water supply, and to inform decisions about water treatment and other system operations.

3.3.3 Source Water Protection Programs

SPU's finished water quality is excellent, in part, because of Seattle's substantial efforts to protect its water sources. Those source protection efforts are described below.

3.3.3.1 Watershed Protection

The primary tool for maintaining source water quality is Seattle's extensive watershed ownership, which allows SPU to restrict human access and activities within the watersheds. SPU has adopted watershed protection programs for the Cedar River and South Fork Tolt River Municipal Watersheds, including the Lake Youngs Reservation, to ensure that SPU's source water remains of high quality and free from contamination. These programs are described in SPU's *Watershed Protection Plan*, which details Seattle's ongoing efforts to control activities that have the potential to adversely affect water quality in both of its surface water supplies. The November 2017 update of this plan was approved by WDOH in April 2018.

3.3.3.2 Wellhead Protection

While the two municipal watersheds supply nearly all of SPU's raw drinking water, SPU has access to groundwater from the Riverton Heights wellfield and the Boulevard Park well, located in the City of SeaTac, for seasonal and emergency use. As part of the *2001 Water System Plan*, SPU prepared and WDOH approved a wellhead protection program, including an inventory of potential contaminants. SPU regularly updates the potential contaminant inventory and sends notification letters to businesses handling or storing potential contaminants within or near the wellhead protection area, as well as to agencies that have influence over activities in the wellhead protection area, including the City of SeaTac and King County Department of Natural Resources and Parks, Groundwater Protection Program. These letters contain maps of the wellhead protection area boundaries and steps that businesses can take to protect the groundwater supply from contamination.

Since the *2013 Water System Plan*, the WDOH susceptibility designation for the Riverton Heights wellfield was changed to "high" from "low" due to the low level detection of dacthal, as described below. The Boulevard Park well designation remains "low" which allows SPU to reduce the frequency for monitoring of some parameters.

3.3.4 Source Water Quality Summary

Water quality characteristics of the raw water from each of SPU's sources, including its three wells, are shown in Table 3-3, below.

Table 3-3. Water Quality Characteristics of SPU's Source Water 2012-2017

Surface Water Sources	Cedar River/Landsburg		Cedar River/Lake Youngs Outlet		South Fork Tolt River/Regulating Basin	
Parameter and Unit	Average	Typical Range	Average	Typical Range	Average	Typical Range
Turbidity, NTU	0.6	0.3 – 1.2	0.4	0.2 – 0.6	0.6	0.2 – 0.9
Temperature, °C	9	5 – 13	12.9	6 – 20	8.7	3 – 14
pH	7.6	7.4 – 7.8	7.7	7.3 – 8.2	7.2	6.9 – 7.4
Alkalinity, mg/L as CaCO ₃	22	15 – 30	20	17 – 23	6.5	5.8 – 7.1
Conductivity, umhos/cm	54	40 – 70	56	49 – 63	23	20 – 27
UVA (@254 nm), cm-1	0.026	0.01 – 0.04	0.017	0.01 – 0.022	0.05	0.04 – 0.06
Total Organic Carbon, mg/L	0.78	0.4 – 1.1	0.8	0.7 – 1.0	1.3	1.2 – 1.5
Total coliform, per 100 mL	433	66 – 1046	186	0 – 2400	124	4 – 305
Fecal coliform, per 100 mL	11	0 – 26	<1	0 – 1	<1	0 – 1

Groundwater Sources	Boulevard Well		Riverton Wells	
Parameter and Unit	Average	Typical Range	Average	Typical Range
Temperature, °C	11	10 – 13	11	9 – 12
pH	7.0	6.9 – 7.1	7.6	7.4 – 7.9
Alkalinity, mg/L as CaCO ₃	150	140 – 170	88	84 – 94
Hardness, mg/L as CaCO ₃	148		83	
Conductivity, umhos/cm	333	313 – 343	223	204 – 245

Contaminants of concern that have been identified in the groundwater sources include radon in all of the wells, and trace levels of dacthal mono- and di-acid degradates in the Riverton Wells which were first detected in 2003. Radon is a naturally-occurring element found in groundwater sources. Dacthal is an active ingredient in herbicides and is found in soils wherever it is used. These contaminants are currently not regulated by the EPA.

3.3.5 Source Treatment Facilities

As described below, treatment facilities located at both surface water sources and at the well locations are operated to provide high-quality finished water to the regional system.

3.3.5.1 Cedar Supply Treatment Facilities

SPU operates two facilities to treat Cedar River source water, the Landsburg Water Treatment Facility and the Cedar Water Treatment Facility.

Why is fluoride added to our water?

We add fluoride at the request of our customers for dental health.

Fluoridation of Seattle's water began in 1970 after a referendum vote in 1968 directed the City to fluoridate the drinking water. SPU provides a fluoride level of 0.7 parts per million according to requirements issued by the State Board of Health.

Public health, dental, and medical authorities overwhelmingly support drinking water fluoridation as safe and effective method of tooth decay prevention. The U.S. Centers for Disease Control have proclaimed drinking water fluoridation as one of the 10 great public health achievements of the 20th century. For more, see www.cdc.gov/fluoridation

Landsburg Water Treatment. At the Landsburg Water Treatment Facility, SPU fluoridates and chlorinates the Cedar supply. Prior to the construction of the Cedar Water Treatment Facility at Lake Youngs in 2004, the Landsburg Water Treatment Facility was the primary disinfection site for water from the Cedar River watershed. The chlorine addition at Landsburg now serves to minimize microbial growth in the transmission pipeline between Landsburg and Lake Youngs and to aid in the control of new organisms (e.g., algae from Chester Morse Lake and lower watershed) entering Lake Youngs.

In 2015, a new operations building was constructed at Landsburg and at that time the gas chlorination facilities were replaced with a liquid, sodium hypochlorite facility. The gas chlorine system was outdated and did not meet building, fire, and safety code requirements. The purpose of the new system remains the same as the former – to apply chlorine to the water – but the new system is safer for the treatment operators and surrounding environment. Along with the new building and hypochlorite system, the SCADA system was modernized and expanded.

Cedar Water Treatment Facility. The Cedar Water Treatment Facility uses ozone, UV light, and chlorine applied in series to ensure inactivation of *Giardia*, *Cryptosporidium*, and viruses. The ozone process also improves the taste and odor of the water from this source. Lime is added at the facility to reduce the corrosivity of the water. The facility has a capacity of 180 mgd.

The Cedar Water Treatment Facility is operated and maintained under contract by CH2M with oversight from SPU. The operations contract began in late 2004. In both 2019 and 2024, the 15- and 20-year marks of the contract, SPU will have the option to renew the existing contract for 5 more years, hire another operations contractor, or use SPU staff to operate the treatment facility. In 2029, the operations contract will expire and a new contract or new operations arrangement will be needed.

Recent upgrades to equipment at the Cedar Water Treatment Facility include work on the UV inlet valves and replacement of the SCADA system and PLCs.

3.3.5.2 Tolt Water Treatment Facility

The 120-mgd ozonation and direct filtration treatment facility for the South Fork Tolt River water began operation in 2001. The facility also provides fluoridation, chlorination, and adjustment of pH and alkalinity for corrosion control.

The Tolt Water Treatment Facility is operated and maintained by American Water CDM with oversight from SPU. The 15-year operations contract began in 2001 and, in 2016, SPU chose to exercise a provision to extend the contract for 5 more years. In 2021, SPU will again have the same 5-year contract renewal option. In 2026, the operations contract will expire and a new contract or new operations arrangement will be needed.

3.3.5.3 Well Field Treatment Facilities

Both well locations include sodium hypochlorite disinfection to provide chlorine residual in the distribution system, fluoridation, and sodium hydroxide addition for corrosion control. Although sodium hydroxide addition is not required, it makes the well water quality more consistent with treated water from the Cedar River, with which it is blended before delivery to SPU customers. Treatment equipment at the well sites is generally in very good condition.

3.3.5.4 Overall Finished Water Quality

The water quality characteristics of treated water as it enters SPU's transmission system are shown in Table 3-4.

Table 3-4. SPU's Finished Water Quality Characteristics

Surface Water Sources	Cedar/Lake Youngs (2012-2017)		Tolt River (2012-2017)	
Parameter and Unit	Average	Typical Range	Average	Typical Range
Turbidity, NTU	0.4	0.2 – 0.6	0.07	0.06 – 0.09
Temperature, °C	12.9	6 – 21	9.7	4 – 15
pH	8.2	8.1 – 8.3	8.2	8.1 – 8.3
Alkalinity, mg/L as CaCO ₃	22	18 - 26	19	18 – 21
Conductivity, umhos/cm	65	57 - 73	60	57 - 62
UVA (@254 nm), cm ⁻¹	0.012	0.008 - 0.016	0.008	0.007 - 0.010
Chlorine residual, mg/L	1.5	1.4 – 1.7	1.5	1.4 – 1.6

Groundwater Sources	Boulevard Park Well (2012-2015) ^a		Riverton Wells (2012-2015) ^a	
Parameter and Unit	Average	Typical Range	Average	Typical Range
Temperature, °C	11	10 - 13	11	9 - 12
pH	8.2	7.7 – 8.7	8.25	8.1 – 8.5
Alkalinity, mg/L as CaCO ₃	124	122 - 126	82	80 - 84
Conductivity, umhos/cm	387	344 - 447	235	222 - 256
Chlorine residual, mg/L	1.5	0.9 – 1.7	1.4	1.2 – 1.6

^a Wells are used infrequently, so data set is relatively small. Wells were not used in 2016 and 2017.

Why did we have to cover the reservoirs?

Federal regulations require that all treated drinking water reservoirs be covered. SPU installed floating covers on two reservoirs, and is replacing its other open reservoirs with underground structures that both improve the quality and security of our water system and provide 76 acres of new open space for everyone to enjoy.

3.3.6 In-Town Storage Facilities

SPU operates several water storage facilities downstream of its Cedar and Tolt Water Treatment Facilities, including covered reservoirs, standpipes and elevated tanks. SPU operates these facilities to ensure that water quality within the distribution system is protected. SPU has established a regular program of inspections for the reservoirs and reports the results of the surveys to WDOH upon request.

3.3.6.1 Reservoir Covering/Burying

SPU completed its open reservoir covering program, although the long-term use of two out-of-service open reservoirs is under evaluation. The approach for covering the open reservoirs was consistent with the *2007 Water System Plan*, and focused on replacing the SPU open reservoirs with new buried structures to improve water quality, increase security, and create new public open space opportunities. Although new park space was created on top of the new buried Lincoln, West Seattle, Myrtle, Beacon and Maple Leaf reservoir sites, the paramount purpose of these sites remains as the storage and distribution of city water supplies and the safety of the drinking water. The replacement projects represent a significant amount of effort and expense. Table 3-4 summarizes the covering program and completion dates.

Table 3-5. Schedule for Covering or Upgrading In-Town Open Reservoirs

Reservoir	Open Reservoir Size (million gallons)	Covered Reservoir Size (million gallons)	Completion
Bitter Lake	21.5	21.3	2001 ^a
Lake Forest Park	60	60	2003 ^a
Lincoln	20	12.7	2006
Myrtle	7	4.86	2008
Beacon	61	48.12	2009
Roosevelt	50	See below ^b	TBD
West Seattle	68	29.21	2010
Maple Leaf	60	61.06	2012
Volunteer	20	See below ^b	TBD
Total	367.5	237.25	

^a Floating cover replacement options, including buried storage, are being evaluated as the floating covers approach the end of their useful life.

^b Roosevelt and Volunteer Reservoirs were removed from service on April 1, 2013, following the completion of the new buried Maple Leaf Reservoir—see text below for more information.

The last two open reservoirs, Roosevelt and Volunteer, were removed from service in 2013. The need to retain emergency

storage at these locations is being evaluated as part of SPU's water system seismic study that is currently underway. That analysis may indicate the need to keep these uncovered reservoirs for emergency storage, which would entail a different set of design and operations and maintenance considerations compared to the potable reservoirs in service. In the future, these reservoirs may be needed as potable water storage, in which case they would be covered.

Lake Forest Park and Bitter Lake Reservoirs were the first two reservoirs to be covered, receiving floating covers between 2001-2003. The floating covers were expected to have a useful life of 20 years. Recently however, at Lake Forest Park, the beginning of some degradation of the cover material has been noted, resulting in an increased number of repairs. SPU has initiated a project to replace the floating cover with a new cover. The schedule for the Lake Forest Park Reservoir cover replacement project construction is currently 2020-2021.

The Bitter Lake Reservoir cover is still holding up well, allowing a cover replacement for this facility to be deferred until after the completion of Lake Forest Park Reservoir cover replacement. Because of this property's topographic conditions and the need to maintain existing reservoir water surface elevation, SPU will explore a number of alternative replacement options in addition to the buried reservoir option similar to what SPU has constructed in other parts of the City. These alternatives will include other hard cover approaches, replacing the existing floating cover, and replacing the reservoir with one or two circular tanks near street grade (surrounded by open space). While schedule for planning, design and construction has not yet been fully vetted, construction may begin in 2022-2023, or later, given the current good condition of the cover.

In collaboration with Seattle Parks and Recreation (and the City of Lake Forest Park, for that reservoir), SPU is conducting an analysis of the public open space and recreational opportunities associated with each of these reservoir upgrade/replacement options.

3.3.6.2 Water Quality Enhancements at Storage Facilities

Some of SPU's enclosed storage facilities were constructed with a common inlet and outlet, or were otherwise designed without considering the optimal water flow conditions needed to maintain water quality by avoiding stagnant conditions. When major maintenance or upgrades are performed on tanks and standpipes, such as interior painting, SPU has been making modifications to

improve water-quality management when appropriate. Upgrade methods include separation of inlets and outlets, installation of mixing systems, multiple level sample taps, and sodium hypochlorite injection points.

3.3.6.3 In-Town Reservoir Treatment

Additional chlorination is provided at some of SPU's in-town storage reservoirs to ensure that chlorine residual is maintained in the drinking water supply until it reaches customer taps. SPU's addition of filtration treatment on the Tolt supply back in 2001, along with the reservoir covering program that is now complete, have reduced the amount of chlorine addition in the distribution system previously necessary. The treatment involves addition of sodium hypochlorite to increase the residual chlorine. At some reservoirs, hypochlorite is generated on-site, while at other reservoirs it is delivered to the reservoir site. The hypochlorite equipment is maintained and repaired on an ongoing basis; for example, pump repair and replacement of hypochlorite generation cells. A list of the chlorination facilities is provided in the treatment facilities inventory in the appendices.

3.3.7 Operations

SPU undertakes a number of activities to ensure that its customers receive high-quality drinking water. Operations activities include water quality monitoring, preventing or eliminating cross connections, responding to customer complaints, storage reservoir cleaning, testing and flushing water mains, and maintaining transmission pipeline water quality. Each activity is summarized below.

3.3.7.1 Comprehensive Water Quality Monitoring Summary

A comprehensive monitoring plan was updated in 2017 and is included as an appendix. The Comprehensive Water Quality Monitoring Summary covers the entire water system, from the watersheds through the transmission and distribution systems to the customer taps. The monitoring plan addresses the following:

- Monitoring requirements under state and federal drinking water regulations.
- Future regulations, which are currently under development at the federal level.

- Non-regulatory monitoring, which SPU conducts for informational purposes and to assist in operating the water system.
- Sampling procedures.
- Managing laboratory information.
- All parameters, locations, and frequency of monitoring conducted by SPU.

3.3.7.2 Cross-Connection Control Program

SPU implements a cross-connection control program to protect the quality of the drinking water supply from cross connections. Within Seattle and the retail service area south of Seattle, SPU's cross-connection program is a joint undertaking with Seattle's Department of Construction and Inspection (SDCI), the Seattle Fire Department (SFD), and Public Health Seattle-King County (PHSKC). Within the City of Shoreline, SPU works with Shoreline city staff members. The program implements all elements of Washington Administrative Code 246-290-490 and includes authority to require that backflow protection be installed or that any cross-connections be eliminated. If water supply protection compliance or backflow assembly testing compliance is not demonstrated by the customer, then SPU will lock out/disconnect the water service at the meter and assess fines to the customer's utility bill. The cross-connection control policy and procedures were included with the *2013 Water System Plan*.

Under the cross-connection control program, SPU oversees more than 27,000 backflow assemblies owned by customers within SPU's retail service area. In 2009, SPU implemented a new database for management of the cross-connection control program, and starting in 2015 there were significant improvements made to both data management and field inspection efforts that have improved data and reporting accuracy, as well as allowed for expanded re-evaluations of known hazards.

3.3.7.3 Customer Complaint Response

SPU has procedures for responding to complaints and problems reported by its retail customers about drinking water quality. The vast majority of complaints concern discolored water, mostly described as muddy/brown but also as yellow/rusty. Discolored water comes from internal pipe rust and sediment getting stirred up. It is an inconvenience, but primarily represents aesthetic issues rather than contamination of the water supply. From 2011 through 2015, an average 1,500 water quality complaints were received per

year. Figure 3-2, below, shows the breakdown of the types of complaints for that period.

SPU retail customers with water quality concerns, water service problems, or questions contact the SPU Call Center during normal business hours and the SPU Operations Response Center after hours and on the weekends. Calls that involve water quality concerns or that identify high priority problems—calls that concern public health issues or safety risks—are passed on to an inspector who will investigate the problem until it is resolved.

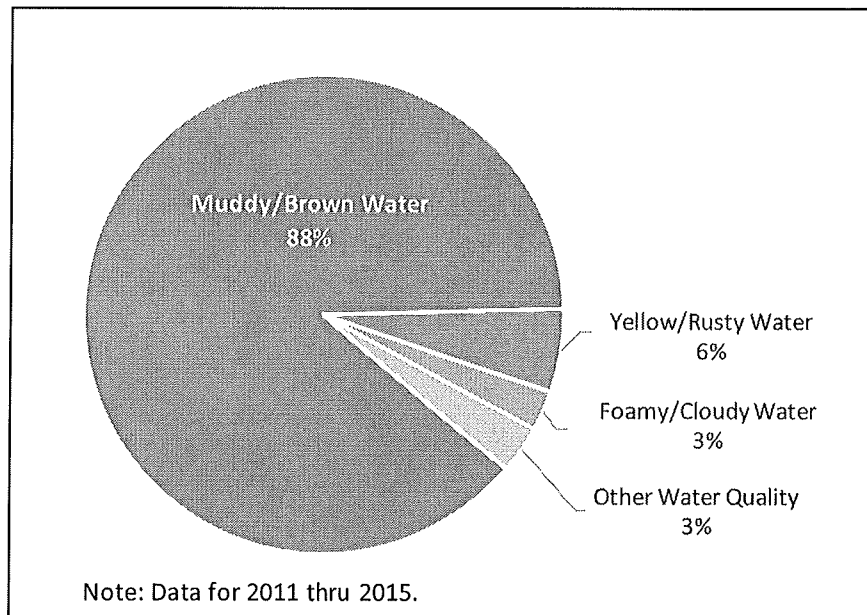


Figure 3-2. Types of Water Quality Complaints

The process for receiving complaints puts the customer in immediate contact with SPU staff and provides SPU with up-to-date knowledge of where the complaints are coming from, the nature of the complaints or problems, and how many calls are being received from a given area of Seattle. SPU logs the complaint information in a computer system and is able to bring these complaints up on a map for further analysis. Because the cause of a problem is usually not known at the time a complaint is called in, improvements are planned to allow revision of complaint data after follow up with the customer so that if the probable cause of the problem is determined, it can be noted and tracked.

3.3.7.4 Transmission and Distribution Storage Facility Cleaning

A key to maintaining water quality after the treated water enters the transmission and distribution system is making sure that

storage facilities are regularly cleaned. Cleaning requires draining of the facility and employs high-pressure washing equipment to wash walls and remove sediment buildup; then the facility is disinfected, refilled and sampled before being returned to service. Approximate cleaning frequency for closed storage facilities is shown in Table 3-6, below. These cleaning frequencies may be adjusted based on inspections. Facilities that store Cedar water are on a more frequent cleaning schedule than those that receive Tolt water because the Cedar supply is not filtered.

Table 3-6. Treated Water Storage Facilities Cleaning Schedule

Type of Reservoir	Frequency of Cleaning
Elevated tanks or standpipes	3-5 years - Cedar supply and/or if interior coating is in poor condition 10-15 years - Tolt supply
Hard-covered reservoirs	3 -5 years - Cedar supply Variable - Tolt supply ¹
Floating covered reservoirs	Variable – Tolt supply ¹
Floating covers (top of cover only)	1 time per year

¹Cleaning frequency depends on dive inspection results.

3.3.7.5 New Water Main Testing

New mains are disinfected and tested as detailed in Section 7-11.3(12) of the City's *Standard Specifications for Municipal Construction*.

3.3.7.6 Water Main Flushing

The primary objective of SPU's water main flushing program is to improve water quality in the distribution system and to reduce customer complaints regarding discolored water. For the past decade, SPU has mainly conducted spot flushing in areas with low chlorine residual or in areas with a high number of customer complaints.

In 2016, SPU re-established a unidirectional flushing (UDF) program in the north end of West Seattle. Over the summer, crews flushed 21 miles of predominantly unlined cast iron pipe in the north end of the 498 pressure zone in response to numerous customer complaints of discolored water. The UDF program for West Seattle was developed from scratch and included the following items: purchase of new flushing equipment, water quality sampling and flushing training for the crews, coordination with drainage and wastewater staff to approve location for discharge of water, documentation and mapping of flushing loops,

development of communication protocols for internal staff and public and collection of regular water quality samples throughout flushing program.

In the summer of 2016, SPU also conducted a pilot program using the Neutral Output Discharge Elimination System (NO-DES) technology in the Arbor Heights area of West Seattle. This truck-mounted system allows flushing of a water main without discharging water onto the ground. Hose is connected to two fire hydrants and water is pumped in a unidirectional pattern through two truck-mounted filter vessels. The pump can be manipulated to control velocity through the loop. On-board analyzers measure pressure, flow and turbidity. This system also allows the user to inject chlorine into the system if necessary. For the SPU distribution system, the NO-DES technology was effective, but not without problems. The roughing and polishing filters clogged faster than anticipated and slowed the overall progress. However, in three days, the crews flushed approximately 5 miles of pipe and removed an estimated 150 pounds of sediment.

In the fall and winter of 2016 and 2017, SPU participated in a Water Research Foundation study related to distribution system flushing. The objectives of the study included: determining the applicability of different flushing techniques for microbial control and mitigation; development of standard operating procedures (SOPs) for flushing and data collection; and development of cost versus benefit to support investment of a flushing program. SPU conducted a UDF pilot in the West Seattle 550 pressure zone and a conventional spot flushing pilot in the Beacon Hill neighborhood where low chlorine residuals are observed in the summer. For the study, SPU conducted several weeks of water quality monitoring in the two pilot areas to develop a baseline for a wide array of parameters (microbial, metals, nutrients and field characteristics). Similar parameters were collected and analyzed during the flush profile and at different intervals after the flush to determine how long any beneficial affects observed lasted in system. The results of this program are still being compiled by an outside consultant.

The information collected during all of the flushing work conducted in 2016 is currently being used to compile where SPU will go next in terms of a flushing program. SPU is in the process of conducting an alternatives analysis to determine what level of flushing will be employed in the distribution system.

3.3.7.7 Water Quality in Transmission Lines

Large-diameter transmission pipelines composed of metal (e.g., steel, ductile iron, cast iron) are often lined with cement mortar to prevent corrosion and deterioration of the metal pipe wall. Cement lining of pipelines can cause the pH in the water to increase (i.e. the water to become more alkaline or basic) when a section of pipeline is taken out of service for repair or maintenance but kept full of water. Although pH is typically not a health issue, unless it becomes extremely low or extremely high, customers may find that water with moderately elevated pH tastes or feels different than that to which they are accustomed. Higher pH can also decrease the effectiveness of chlorine for disinfection. Additional customer concerns could include loss of aquarium fish or adverse impacts on commercial and industrial facilities.

For the temporary situations where water in transmission lines exhibits elevated pH, SPU established the following guidance:

- Water with pH up to 9.5 can be sent to the distribution system.
- If water in the pipeline has pH above 9.5, the pipeline will be flushed.
- In emergency circumstances, the SPU Water Quality Director may allow the pH 9.5 limit to be exceeded.

If future experience shows that the upper pH limit of 9.5 is inappropriate, this guideline will be revised.

3.3.7.8 Distribution System Water Quality

Water quality within the distribution system is monitored a variety of ways. The majority of this monitoring occurs as part of compliance with the Total Coliform Rule. Parameters include total coliform, *E. Coli*, chlorine residual, and water temperature. Total coliform and *E. Coli* results were covered previously in this chapter. Chlorine residual is measured each time a total coliform rule sample is collected. For any chlorine result less than or equal to 0.2 mg/L, a heterotrophic plate count (HPC) test is also conducted. Since 2012, there have been over 3100 HPC tests run on total coliform rule samples from the Seattle distribution system. HPC results for all of these samples have been below 500 cfu/mL, and less than 0.5% of the samples had HPCs above 10 cfu/mL. This indicates very good distribution system water quality, even when chlorine residual is low.

Chlorine residual is also monitored daily at several locations along the transmission pipelines, twice a month at finished water storage facilities, and as part of customer calls, new mains, flushing projects, and main break samples. On average, there are almost 1000 grab samples analyzed for chlorine residual each month. For all total coliform rule samples with chlorine less than or equal to 0.2 mg/L, an alert email is sent to several SPU staff within 24 hours. For any finished water storage facility sample with a chlorine less than 0.6 mg/L, the in-town treatment staff are notified, and the chlorine level is rechecked. If chlorine is less than 0.6 mg/L, the tank is boosted with additional chlorine.

There are a few locations within the distribution system that are known to have low chlorine, usually on a seasonal basis. Data for these locations are plotted each month to analyze short and long-term trends. These trends are used to make decisions on chlorine treatment levels for the primary treatment plants, and in-town re-chlorination systems at storage facilities. Generally, chlorine treatment targets are increased in the summer months when water is warmer, and decreased in winter months. These chlorine trends are also used to determine flushing needs. Areas around sample stands with chlorine consistently less than 0.2 mg/L are flushed whenever possible, during summer and fall months.

Other parameters that are monitored in the distribution system include temperature, pH, and conductivity. Average, minimum, and maximum temperature for the distribution system is calculated monthly, and generally graphed on a seasonal or bi-annual frequency. Conductivity and pH samples are collected throughout the distribution system at roughly 30 locations each week. The pH data is analyzed monthly to determine trends, and compared to treatment plant pH data when results differ from normal.

3.3.8 Maintenance

SPU developed an asset management plan (AMP) for its water treatment facilities at Cedar (Landsburg and Lake Youngs), Tolt, and Boulevard Park and Riverton Heights wells, as well as in-town disinfection facilities, in 2009 and updated in 2013. This AMP describes the infrastructure, their operations and maintenance, relevant service levels, repair and replacement needs, data needs, and other relevant asset information. Additionally, more detailed maintenance activities for the Cedar and Tolt Water Treatment Facilities are covered by the service agreements for those facilities. Some examples of projects at treatment facilities are the upcoming replacement of UV inlet valves at the Cedar facility and evaluation of alternatives for replacing the lime slaker system at the Tolt

facility. Routine maintenance of the SPU Drinking Water Quality Laboratory facility is conducted by Seattle Finance and Administration Services. SPU staff complete maintenance, repair, and replacement of laboratory specific equipment and instrumentation.

3.4 NEEDS, GAPS, AND ISSUES

In the past decades, SPU has made significant capital improvements to ensure that its water is of the highest quality while meeting current and future regulations. In particular, SPU's completion of the Tolt and Cedar Water Treatment Facilities has significantly improved SPU's water quality. However, these facilities are no longer new and will require replacement or rehabilitation of major equipment or components in the upcoming decades. In addition, SPU's activities to cover, bury, or decommission its open reservoirs also demonstrate SPU's efforts towards ensuring excellent water quality in its system.

There are always new challenges for SPU to confront as it strives to meet its high standards for drinking water quality, including changing regulations. The following sections summarize the needs, gaps, and issues facing the Water Quality and Treatment business area and describe the SPU plans to address them.

3.4.1 Water Treatment Facilities Major Maintenance and Potential Upgrades

The existing contracts for the Tolt and Cedar treatment facilities were initiated in 2001 and 2004, respectively, and were intended as long-term, 25-year service agreements. The current contracts cover operations as well as funds scheduled for major maintenance projects. After the contracts expire, it should be reasonably anticipated there will be some increased repair and replacement costs for aging components, such as the ozone generators and chemical piping, and potentially increased operational expenses under new service agreements. The Cedar supply remains unfiltered under the Limited Alternative to Filtration regulatory status. Should regulations or operational conditions change in the future such that filtration need to be added to the treatment process, capital needs would increase. These potential needs have been included in the long-term capital budget.

3.4.2 Future Regulatory Changes

The only regulations currently under development by EPA are for perchlorate and chromium, as well as Lead and Copper Rule

(LCR) Long-Term Revisions. EPA has also proposed a rule regarding the use of lead free pipes, fittings, fixtures, solder and flux. The impacts that these regulatory changes could have on SPU are explained below.

Since the *2013 Water System Plan*, one additional staff has been added to the Laboratory Technician group whose primary role is collecting drinking water samples and conducting field data analysis. This need may expand in future years if regulatory sampling requirements increase.

3.4.2.1 Perchlorate

Perchlorate has not been detected in previous sampling, and SPU does not anticipate issues meeting any future perchlorate regulation.

3.4.2.2 Chromium

Total chromium and chromium 6 were included in testing conducted under UCMR3, described in the next section. The levels of total chromium found in SPU's drinking water ranged from <0.2 to 0.33 ug/L. The levels of chromium 6 found ranged from 0.063 to 0.17 ug/L. Since SPU's source waters have no industrial activities that would introduce chromium 6, it is assumed that the chromium 6 is converted from the naturally occurring chromium 3 during the disinfection process.

The current MCL for total chromium is 100 ug/L. Currently chromium 6 is not regulated, but EPA may decide to revise the regulations to include chromium 6 based on its final human health assessment. It is not clear when this assessment will be available.

3.4.2.3 Lead

The LCR Long Term Revisions have been under consideration for several years now. Part of the process included a white paper that provided examples of regulatory options, including lead service line replacement, improving optimal corrosion control treatment requirements, consideration of a health-based benchmark, potential for point-of-use filters, clarifications or strengthening of tap sampling requirements, increased transparency, and public education requirements.

SPU's compliance with the revisions will depend on which options are finalized. Most of the proposed options should have little to no impact to SPU's compliance status. The biggest change could be

the inclusion of services with lead whips or “goosenecks” in the sampling pool. SPU’s direct service area has an estimated 2000 services with lead whips, which were formerly used as short, flexible connections from a water main to a galvanized service. However, the location of the remaining lead whips is unknown within a group of over 8000 galvanized services. It would be difficult to find services with lead whips in order to conduct the sampling. Also, if the options include required removal of all lead components, including whips, SPU would have to replace all 8000 galvanized services to ensure that all lead whips were removed. SPU’s current approach is to remove the lead whips when replacing a service line for other reasons or when a lead whip is discovered.

EPA has also proposed a rule regarding the use of lead free pipes, fittings, fixtures, solder and flux. The definition of “lead-free” was established in Section 1417 of the Safe Drinking Water Act as having a weighted average of 0.25% lead for wetted surfaces, and 0.2% lead for solder and flux. SPU has already done an inventory of the warehouse, and now uses only lead-free plumbing products. SPU also replaced certain types of large meters because of this new definition, as described in Chapter 4.

3.4.3 Emerging Contaminants of Concern

Emerging contaminants are not regulated, they are generally new to drinking water scientists, and there is typically limited information about their occurrence and health effects. Understanding the significance of emerging contaminants can be difficult and complex given that lack of clear data. EPA takes on emerging contaminants primarily through the Contaminant Candidate List and the Unregulated Contaminant Monitoring Rule. In addition, SPU has made its own efforts regarding some emerging contaminants in order to better understand the quality of SPU’s water supply.

3.4.3.1 Contaminant Candidate List

The majority of the CCL contaminants present relatively low concern to SPU.

The Safe Drinking Water Act directs EPA to publish a Contaminant Candidate List (CCL) every 5 years and EPA finalized the third list (CCL4) in 2016. It includes 97 chemicals or chemical groups and 12 microbiological contaminants. These contaminants occur or are anticipated to occur in public water systems. Contaminants on the CCL4 are not currently regulated and the list does not impose requirements on public water systems. EPA uses the list to prioritize research and data collection efforts to help determine if a contaminant should be regulated.

The majority of the CCL4 contaminants present relatively low concern to SPU because of its excellent source protection practices, modern water treatment facilities, and distribution system practices. Contaminants on the list that have been detected under UCMR3 include chlorate and vanadium. Two that may impact SPU and will be monitored under UCMR4 are manganese and cyanotoxins. SPU will continue to stay up to date on EPA regulatory determinations as well as participate in or stay informed on related studies and national occurrence of emerging contaminants.

3.4.3.2 Unregulated Contaminant Monitoring Rule

The Unregulated Contaminant Monitoring Rule (UCMR) is EPA's program for gathering public water system data on contaminants without current health based standards. Monitoring results are used for determination of future drinking water regulations. EPA requests or requires participation from a utility, depending on its size.

The UCMR monitoring rounds occur on a 5-year cycle, is largely based on the CCL, and the list may contain no more than 30 contaminants. SPU participated in UCMR 1 (conducted 2001-2005), UCMR 2 (conducted 2007-2010), UCMR3 (conducted 2013-2015), and will participate in UCMR4 in the 2018 to 2020 period.

Under UCMR3 monitoring, there were a total of five contaminants detected, and 23 contaminants that were not detected. These were reported in Seattle's 2015 Consumer Confidence Report. The detected contaminants were strontium, vanadium, total chromium, chromium 6, and chlorate. None of these currently have a regulatory limit, and it is not clear when they might be regulated in the future. The non-detected contaminants included several perfluorinated compounds, such as PFOS and PFOA, and several hormones (pharmaceuticals).

UCMR4 monitoring includes 10 cyanotoxins, 9 haloacetic acids, germanium, manganese, 9 pesticides, 3 alcohols, and 3 SVOC's. The only contaminants expected to be detected in SPU's UCMR4 monitoring are those we have already detected, which includes manganese, monochloroacetic acid, trichloroacetic acid, and dichloroacetic acid. The last three are currently regulated under the Stage 2 DBP Rule (covered earlier) as part of the HAA5's. SPU's current levels are below the required limits for HAA5.

3.4.4 Kerriston Road in the Cedar River Watershed

Kerriston Road is a King County road that traverses the northwest portion of the Cedar River Municipal Watershed within the hydrographic boundary for more than two miles. The road provides the only existing access to 322 acres of privately-owned property located outside the northern municipal watershed hydrographic boundary. WDOH has expressed concern about the potential public health and water quality impacts that could result from public use of the road. The 2009 acquisition of the 4,000 acres by King County and the Washington Department of Natural Resources in the Raging River area reduced the total area of privately-owned property accessed by the Kerriston Road by 84 percent, significantly reducing the scale of the potential future development threat and investment to acquire remaining properties.

In 2008 SPU conducted a feasibility study and cost estimates for acquiring the private properties accessed by the Kerriston Road. A portion of the property, about 148 acres, has been purchased. In 2011 SPU conducted a risk-cost analysis to determine if the cost of additional land acquisition to mitigate the risk of public access on the Kerriston Road was warranted. The analysis determined that the risk is extremely low and does not warrant the expenditures required to acquire the Kerriston properties. However, increased trespass in this area may prompt SPU to revisit the risk assessment in the future, and explore other approaches to risk mitigation besides land acquisition, such as entrance gates.

3.4.5 Lake Youngs Water Quality

Lake Youngs is a high quality, oligotrophic lake, meaning it has low nutrient content and low biological productivity. In recent years, SPU has observed some changes in Lake Youngs' water quality, particularly some new dominant algal species and less predictability in the timing of algal blooms. SPU held a workshop of limnology experts in 2009 to look more closely at the water quality data and determine if these changes in algae are indicative of more fundamental or permanent changes in the lake. The expert panel concluded that the types of changes observed are well within normal ranges and do not suggest any significant degradation of the lake.

Algal blooms have been observed in Lake Youngs since the 1920s. Prior to the startup of the Cedar Water Treatment Facility, these algal blooms would cause undesirable tastes and odors in the drinking water. The new treatment facility has eliminated nearly

all these effects. Another effect of algae has been that over time it can accumulate on water filters used in homes and businesses. One of the newer dominant types of algae in the lake, *Cyclotella* (recently renamed *Lindavia*) has been found to produce fine filaments that not only clog filters, but accumulate on screens used in the water system. Because of the more problematic nature of these filaments, SPU strives to avoid this algae by bypassing Lake Youngs during a bloom. Since 2008, *Cyclotella* has produced an active bloom in Lake Youngs requiring bypass operations ranging from a few days to several months every year except 2015. Bypass operations are successful in avoiding use of the lake water except during the relatively short periods when the river water is unacceptable due to high turbidity or low UV transmittance from rain storms.

SPU has an extensive lake monitoring program. In response to the changes in the lake and recommendations of the expert panel, SPU added to that program in order to better characterize the lake. Water quality monitoring has been improved with the addition of some sampling and the installation of a remote floating water quality monitoring station on the lake. Six parameters (temperature, turbidity, pH, chlorophyll-a, dissolved oxygen, and conductivity) are measured multiple times each day at depths ranging from just below the surface to 30 meters.

3.4.6 Aquatic Nuisance and Invasive Species

Several aquatic organisms currently create or have the potential to create nuisance conditions in Washington state waters, including SPU's drinking water supplies. Once established in an aquatic system, infestations of these nuisance organisms can be difficult to control and impossible to eradicate, resulting in deleterious effects on water quality and water system operations.

Several aquatic nuisance species are specific targets of SPU's prevention program because of their proximity to the Cedar River, ease of invasion, or significance of impact. The invasive aquatic plant species include: *Eurasian milfoil*, parrotfeather, *Hydrilla*, *Brazilian elodea*, fanwort, water hyacinth, and others. The microorganism species include *Didymosphenia geminate* (didymo), Whirling Disease, and others. The animal species include the zebra mussel, quagga mussel, New Zealand mud snail (NZMS), Chinese mitten crab, and others. All of the aquatic nuisance plant species listed here have been positively documented in freshwaters of Washington State, including NZMS in Seattle's Thorton Creek.

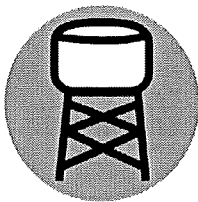
SPU's "Prevention of Aquatic Nuisance Species Plan" outlines general responsibilities of field personnel working in any of the water supply reservoirs and watersheds. A detailed equipment decontamination procedure is included in the plan. In addition to preventing the introduction of aquatic nuisance species, the decontamination procedure is designed to prevent contamination by any biological organism (i.e., plant, animal, or microbe) that is either a native or exotic species and may be terrestrial or aquatic in origin, and by any chemical or petroleum product.

3.5 IMPLEMENTATION/ACTION PLAN

With the completion of the reservoir covering program, SPU has accomplished a great deal since the *2013 Water System Plan*. These actions have supported SPU in meeting drinking water quality regulations. Actions and projects identified in this chapter so that SPU will continue to meet water quality requirements in the future include the following:

- Evaluate the need to retain non-potable emergency storage at Roosevelt and Volunteer Reservoirs as part of SPU's water system seismic study.
- Replace the floating covers at Bitter Lake and Lake Forest Park Reservoirs.
- Evaluate contract extension options for the Tolt and Cedar Water Treatment Facilities, and plan for upgrades as these facilities age.
- Review distribution system flushing practices and the level of resources allocated to flushing.
- Remove lead whips when these are found while replacing service lines for other reasons or when a lead whip is discovered.
- Stay abreast of EPA and WDOH regulatory development efforts and make adjustments as necessary to ensure that SPU's water quality service level is always met.
- Continue monitoring the science regarding new or emerging contaminants of concern, and continue to monitor source and finished drinking water to determine whether these contaminants are at levels of concern in SPU's supplies.

- Revisit the risk-cost analysis of public access on the Kerriston Road if there is an increase in trespass in the area to determine if additional land acquisition is the preferred approach for mitigating the risk of impairing Cedar source water quality.
- Continue to monitor and characterize limnological conditions in Lake Youngs as it affects Cedar supply operations and treated water quality.
- Bypass Lake Youngs to avoid problematic algae from entering the water system.
- Continue efforts to prevent aquatic nuisance and invasive species from being introduced into SPU's drinking water supplies.



CHAPTER 4

WATER TRANSMISSION SYSTEM

SPU's water transmission system consists of the large diameter pipelines, storage facilities, pump stations, and related infrastructure that convey raw water to the treatment facilities and treated water to the distribution systems of SPU's wholesale customers and its own retail service area. The water transmission system consists of both regional and sub-regional facilities, as defined in the wholesale water contracts and shown in Figure 4-1.

4.1 ACCOMPLISHMENTS SINCE 2013 WSP

Since completion of the *2013 Water System Plan*, SPU has implemented the number of improvements to the water transmission system to improve reliability:

- Tolt Slide Monitoring and Management:
 - Acquired fee ownership of the land uphill from the active slide area to assure reliable re-vegetation and future logging (2013).
 - Removed an ineffectual large rock buttress to reduce unnecessary weight on most instable portion of slope (2014).
 - Constructed series of five large engineered log jams at the toe of the unstable slope to protect it from further erosion by the North Fork Tolt River (2015).
 - Cut out a buckled welded joint on Tolt Pipeline No. 2 (TPL2) and replaced it with a welded butt strap (2015).
 - Reset the position of the double ball expansion coupling which had reached maximum available deflection (2017).
- Cathodic Protection Program:
 - Bar Wrapped Pipe (BWP). Completed a pilot project that found actual costs of impressed current cathodic protection on BWP would be much higher than expected, and installed a passive cathodic protection system on a steel slope section.

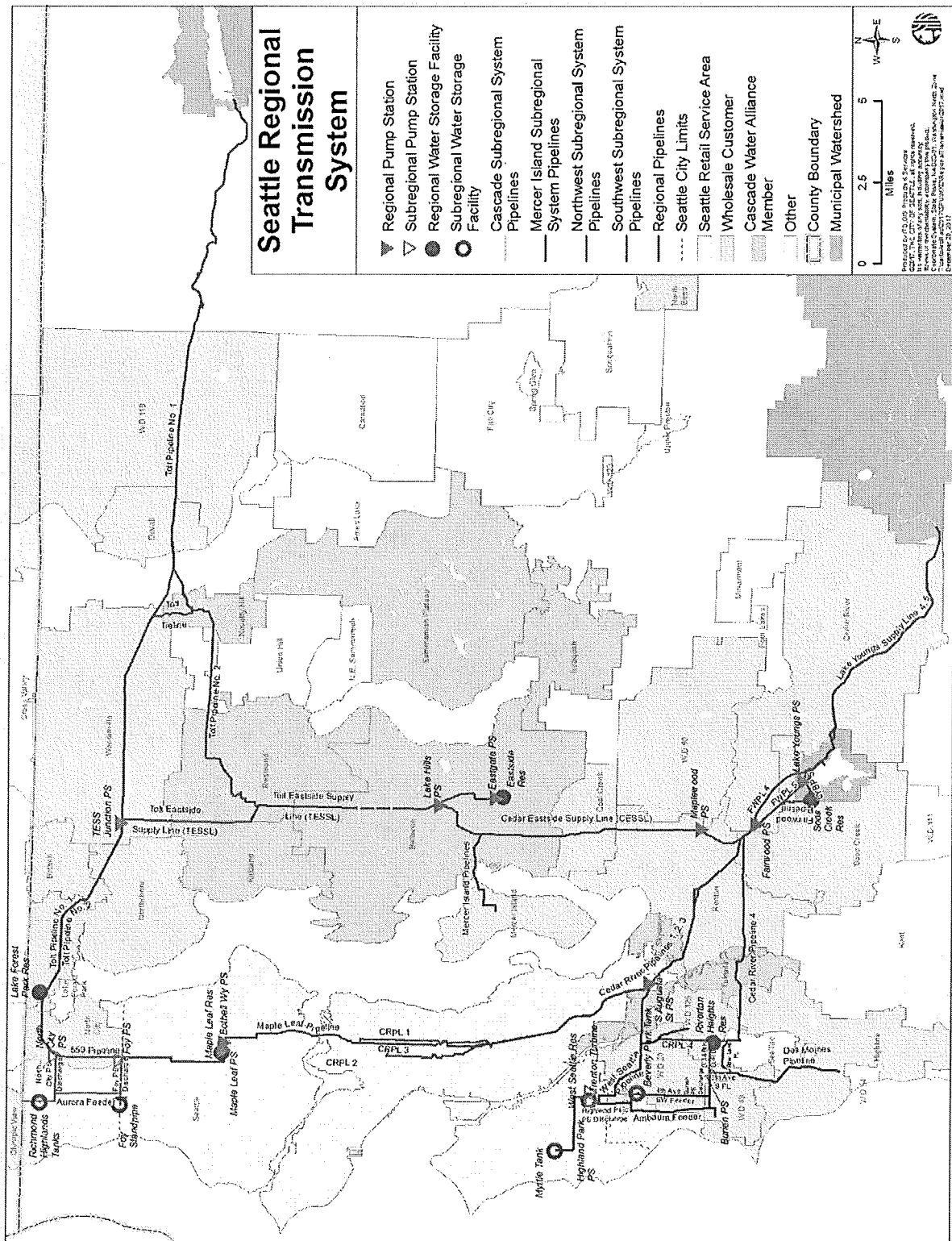


Figure 4-1. Seattle Regional Transmission System

- Older Steel Pipelines. Replaced and expanded several depleted cathodic protection systems on older steel pipelines.
- Video Inspections: Acquired the necessary equipment and developed in-house expertise in remote controlled video camera internal inspections of water transmission pipelines.
- Wholesale Customer Meters:
 - Added two new wholesale services as requested by its whole sale customers primarily to improve retail service reliability within the wholesale customers' service areas.
 - Replaced several Rockwell turbine meters due to anticipated federal regulations banning re-installation of leaded brass components in contact with drinking water.
- Automation:
 - Added automated operation option for a remote-controlled ball valve controlling flow from CRPL1 into the Volunteer 430 Zone and into the south end of the 430 Pipeline, which improves system control to the Volunteer 430 Zone when the 430 Pipeline is out of service.
 - Installed remote control via SCADA on a diesel engine driven pump providing emergency backup to the Richmond Highlands 590 Zone to allow planned decommissioning of the small Richmond Highlands Tank and Foy Standpipe (possible future).
- Tanks and Standpipes:
 - Removed from service the small Myrtle Tank (#1).
 - Completed exterior recoating of Foy Standpipe.

4.2 SERVICE LEVEL PERFORMANCE

SPU has developed service levels that deal with the water service SPU provides to its wholesale customers. From a wholesale customer's perspective, the quality of water service can be measured by the amount of water flow provided, the pressure of that water, and the duration of any water system outages. Many of the drinking water quality service levels, as stated in the Water Quality and Treatment chapter, also apply to the transmission

system. Table 4-1 summarizes SPU's service levels concerning service provision to wholesale customers.

Table 4-1. SPU's Service Levels for Managing Transmission System Assets

Service Level Objective	Service Level Target
Provide agreed-upon service to wholesale customers.	• Meet wholesale contract requirements for pressure and flow. • Limit each unplanned outage in the transmission system to be within the maximum outage duration set for each pipe segment (24, 48 or 72 hours).

These service level targets have been met since 2006. SPU's wholesale contracts require SPU to provide a minimum pressure and maximum flow rate at each wholesale service connection, with contingencies for emergency or unusual conditions. There have been no contractual compliance issues in recent years. Additionally, there have been no unplanned outages of the transmission pipelines that have exceeded SPU's service level for maximum outage durations.

4.3 EXISTING SYSTEM AND PRACTICES

SPU's regional and sub-regional water transmission systems include 193 miles of pipeline, 7 covered reservoirs, 15 pump stations, 7 elevated tanks and standpipes, and 131 wholesale customer taps with meters.

SPU's transmission system consists of the facilities that convey bulk water to wholesale customers throughout the regional service area, as well as to SPU's own retail service area distribution system. SPU's transmission system facilities include the large-diameter transmission pipelines, storage facilities, pump stations, wholesale customer meters, and other appurtenances that are used in conveying water from SPU supply sources to its wholesale customers and the SPU retail service area.

4.3.1 Existing Infrastructure

The regional and sub-regional water transmission systems include approximately 193 miles of pipeline, seven covered reservoirs, 15 pump stations, and seven elevated tanks and standpipes. Taps off of the major supply transmission pipelines from the Cedar and Tolt sources deliver water to 131 wholesale customer master meters and intertie locations. Wholesale customers operate their own distribution systems serving their own retail customers. Brief descriptions of the elements that comprise transmission system infrastructure are presented below, along with assessments of the condition of related assets. Inventories of the primary transmission system facilities are provided in the appendices.

4.3.1.1 Pipelines

SPU's transmission system contains approximately 193 miles of large-diameter pipelines. These pipelines convey untreated water from the supply sources to the treatment facilities and treated water from the treatment facilities to the wholesale and retail service areas. Figure 4-2 depicts the length of transmission pipelines by pipe barrel material installed by decade. The bulk of these pipelines are made of steel and bar wrapped pipe, with a small portion consisting of ductile or cast iron and concrete. As shown in Figure 4-3, these pipes vary in size from 20 to 96 inches in diameter, with some connections and bypasses being smaller.

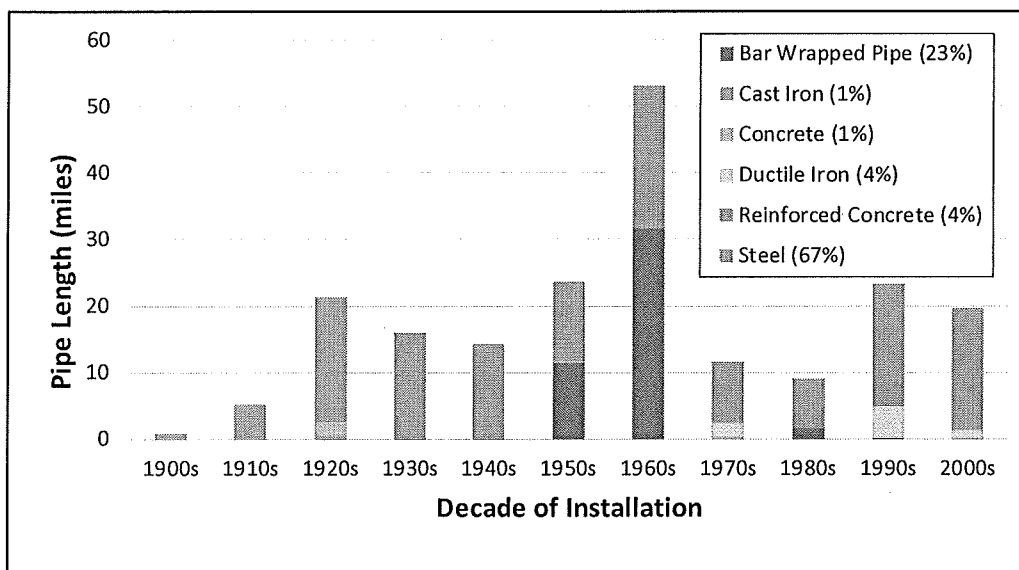


Figure 4-2. Type of Material and Decade of Installation for Transmission Pipes

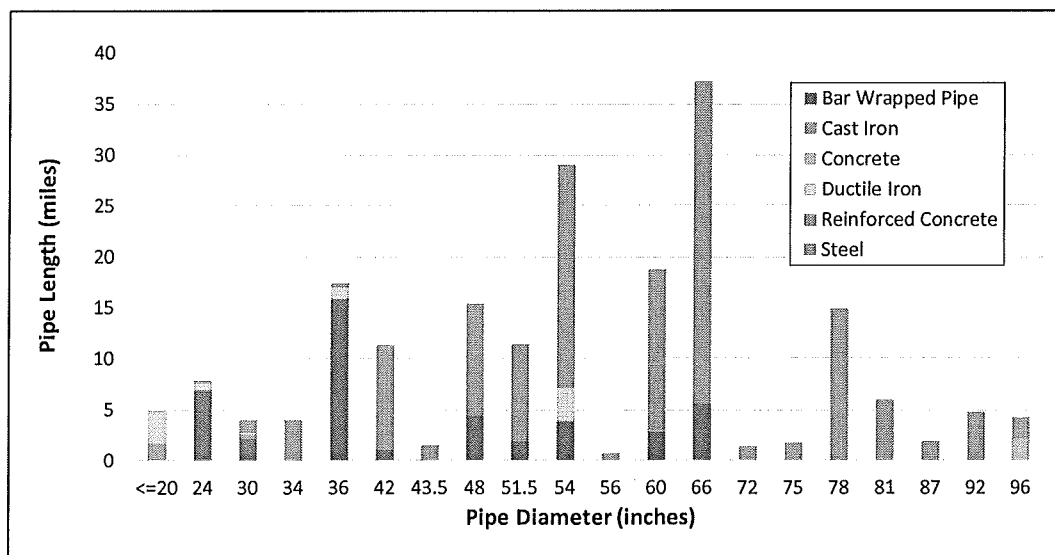


Figure 4-3. Breakdown of Transmission Pipeline Material by Size

SPU relies on the leakage history and visual inspections of its transmission pipes to provide an indication of condition. Leaks are identified by SPU crews that drive along the alignments of the transmission pipes weekly to look for water ponding on the surface. Leaks on transmission pipelines are rare, less than 0.016 leaks per 100 miles in recent decades, as in Figure 4-4, below.

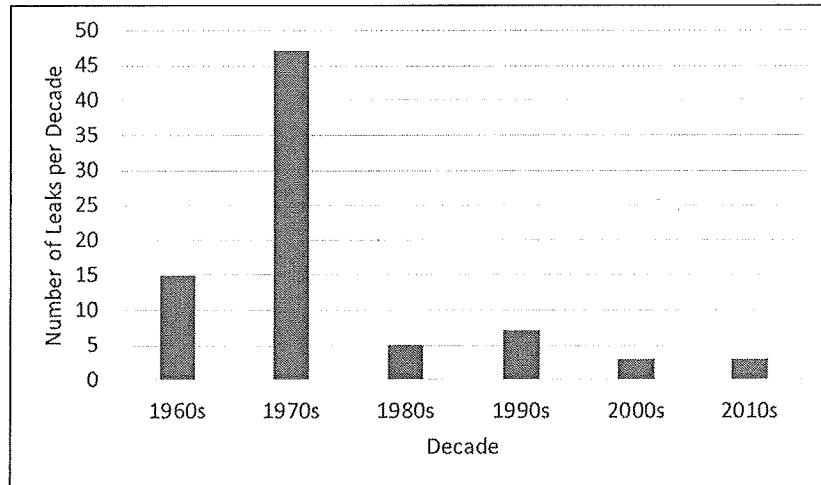


Figure 4-4. Number of Transmission Pipeline Leaks per 100 miles by Decade

Appurtenances related to the transmission pipelines are described below.

Line Valves. Line valves are typically 24-inch and larger, and are used to isolate a pipeline segment between two of them when the need arises. This could occur on a planned or emergency basis. There are about 150 line valves along SPU's transmission pipelines, and it is important that they operate properly when needed. Otherwise the length of pipeline to be out of service increases with each line valve failure.

Air Valve Assemblies (AVAs). There are about 340 AVAs along SPU's transmission pipelines. AVAs are typically installed at local high points and during normal operation let off-gassed air out of the water flow. During pipeline filling AVAs let the air displaced by the incoming water out, while during pipeline draining they let air in to prevent vacuum conditions. Many AVAs include more than one individual air valve.

Blowoffs (BOs). There are about 240 BOs along SPU's transmission pipelines. BOs are typically installed at local low points, and during normal pipeline operation serve no purpose. BOs allow the pipeline to be drained when necessary for inspection

or repairs. SPU flushes and exercises each BO once a year to assure that the outlet valve off the pipeline remains operational.

4.3.1.2 Storage

How long does it take the water to get to my house?

It typically takes about two weeks for the water to get from the treatment plants to your faucet.

SPU owns, operates, and maintains 15 storage facilities in its transmission system. All store treated water. An assessment of the condition of these facilities is described below.

Reservoirs. With completion of the Maple Leaf and West Seattle reservoir burying projects in 2010, all seven of SPU's treated transmission system reservoirs are covered. Except for Lake Forest Park Reservoir, these reservoirs are pre-stressed or reinforced concrete tanks. Lake Forest Park Reservoir was constructed in 1961-62, and its structure consists of a hypalon-lined, reinforced concrete slab with a floating cover that was added in 2002.

The condition of the reservoirs is typically assessed by inspecting the structures, the embankment stability, the valves and piping, and any internal lining, and measuring the leakage rate from the reservoirs. When evaluating leakage rates, SPU looks for increasing trends and anomalies that could indicate deteriorating conditions at the reservoir. SPU performs routine structural inspections of the tanks during cleaning activities to assess their condition and ensure that they meet regulatory requirements. Minor and major deficiencies are addressed through capital programs when they are identified.

Periodic inspections reveal that the storage reservoirs are in good condition. The leakage rates from Soos North and Soos South Reservoirs are low, 0.11 gallons per minute per million gallons (gpm/MG) and 0.04 gpm/MG, respectively, when tested in 2006-2007. Riverton Heights and Lake Forest Park Reservoirs had negligible leakage when last tested in 2016 and 2017, respectively. Eastside Reservoir has not been tested for leakage since completion of the sealant project, and West Seattle Reservoir has not been tested since it was replaced and seismically upgraded.

Standpipes and Elevated Tanks. The SPU water transmission system includes four elevated tanks, one standpipe, and two control works surge tanks to provide drinking water storage. The elevated tanks and standpipes were constructed between 1925 and 1959. They range in capacity from 0.3 to 2 MG. Myrtle #1 Tank was removed from service in 2012 and Richmond Highlands #1 Tank is planned to be removed from service for decommissioning

as well. Foy Standpipe was evaluated for decommissioning, but near-term plans are for the tank to remain in service.

Tanks, including standpipes, are expected to have a service life of approximately 100 years with regular maintenance. SPU inspects the tanks visually to evaluate their condition and appearance. Structural inspections are conducted when tanks are drained for cleaning. Exterior sanitary inspections are conducted quarterly. The condition of the tanks is evaluated for the condition of interior and exterior coatings, as well as its valves and pipes. The condition of each tank varies, depending on its year of construction and the year the last interior and exterior coatings were applied.

SPU has an on-going tank and standpipe recoating program. The program involves safety modifications at tank sites, minor structural repairs, and interior and exterior surface preparation and coating following a regular maintenance cycle. Tank painting generally follows an approximate 25- to 30-year cycle. The timing will vary with need as shown by inspections and economic analysis. Myrtle Tank #2 was recoated in 2010, Richmond Highlands Tank #2 in 2012, and Foy Standpipe exterior in 2017. Beverly Park Tank is scheduled for recoating in 2019-20.

4.3.1.3 Pump Stations

SPU operates 15 transmission system pump stations. These pump stations are inspected regularly and equipment is repaired or replaced as needed. The condition of SPU's pump stations varies depending on the age and condition of their components, their usage, past maintenance or rehabilitation activities, and other factors. SPU is implementing a Reliability Centered Maintenance (RCM) program for its pump stations, which is described more fully in Section 4.3.3.3. Additionally, SPU intends to continue condition assessment work on its pump stations. This condition assessment, in conjunction with findings from SPU's RCM program, will be used to update SPU's pump station asset management plan.

4.3.2 Operations

Since completion of the Cedar Water Treatment Facility in 2004, water from the Cedar source is pumped from Lake Youngs into the treatment facility and flows through the treatment processes by gravity to the clearwells. From the clearwells, flow to Control Works is through two finished water pipelines (FWP) and flow control facilities (FCF). FWP No. 4 and FCF No. 4 deliver water directly to Control Works through the former Lake Youngs Bypass

No. 4 pipeline. FWP No. 5 and FCF No. 5 deliver water to the Lake Youngs tunnel through the former Lake Youngs Bypass No. 5 pipeline. From the Control Works, water flows to the four Cedar River Pipelines (CRPLs) for transport to wholesale customers generally east and south of Lake Washington, and to SPU's retail service area. A maximum of 200 mgd of treated water can be transmitted from the Cedar Water Treatment Facility clearwells through the Cedar River pipelines, but flow is constrained by the Cedar Water Treatment Facility treatment capacity of 180 mgd.

For the Tolt source, raw water is delivered from the South Fork Tolt Reservoir to the Regulating Basin either through the original South Fork Tolt Pipeline or through the Seattle City Light penstock pipeline installed in 1995. From the Regulating Basin, which serves as a break in the hydraulic grade line and as regulating storage for hydropower production, the raw water moves through a screenhouse and then into Tolt Pipelines Nos. 1 and 2 to the inlet of the Tolt Water Treatment Facility.

Treated water from the clearwells of the Tolt Water Treatment Facility flows west in the original and, in some places, replaced Tolt Pipeline No. 1 (TPL1) to the Duvall area where TPL1 bifurcates into TPL1 and Tolt Pipeline No. 2 (TPL2). TPL2 follows a separate southwesterly alignment and connects to the Tolt Eastside Supply Line in Kirkland. TPL1 runs west and connects to the north end of the Tolt Eastside Supply Line (TESSL) in Woodinville. West from the Woodinville area TPL1 and TPL2 follow the same original right-of-way to Lake Forest Park Reservoir. TPL2 is in active mode along this stretch whereas TPL1 is in standby mode at lower pressure. TPL1 is kept fresh by maintaining a low level continuous discharge directly into Lake Forest Park Reservoir whereas the main supply to the reservoir comes from TPL2. The Tolt transmission facilities are capable of hydraulically delivering 135 mgd through the treatment facility and downstream transmission pipelines; the treatment capacity is 120 mgd.

SPU has performed extensive hydraulic modeling analysis, and has implemented capital improvements to reduce the likelihood of water service interruption in case of unplanned source outage. As a result, the SPU system is expected to be able to meet indoor and off-peak season water use of the entire service area, most likely including the wholesale customer demand, for at least seven days with only one of its two main sources available. In case of an unexpected source outage during higher demand periods, SPU plans to reduce water demand to indoor levels through aggressive public messaging in the media. More information on system

performance under these scenarios is provided in the appendix on System Storage and Reliability Standard contained in the *2013 Water System Plan*. Such responses to emergency outages are covered in the updated Water Shortage Contingency Plan.

4.3.3 Maintenance

Proper maintenance of SPU's transmission system components ensures that SPU will be able to deliver reliable water service, reduce the risk of unexpected failures, and provide safe drinking water to its wholesale and retail customers.

SPU has prepared an asset management plan (AMP) for its transmission system. The AMP covers transmission pipelines and appurtenances, such as line valves, air valves, blowoffs, and pipeline right-of-way, and outlines maintenance and renewal strategies for each. Transmission pump stations, reservoirs and tanks are not covered in the Transmission System AMP since they share similar characteristics with their respective Distribution counterparts. Consequently, AMPs will be developed to cover all water pump stations, water reservoirs, water tanks and standpipes, etc.

Summaries of the maintenance strategies of the core transmission system components are provided in this section.

4.3.3.1 Pipelines

Maintenance strategies related to the pipelines and related appurtenances are described below.

Pipe barrel. Maintenance activities for the pipe barrel of water transmission pipelines are rather limited as the pipe barrel is typically buried. External inspections are performed only when opportunities present themselves, such as when a pipeline barrel is exposed for other work.

Lockbar pipe is manufactured by connecting two half-circle steel plates with an H-shape bar along each of the two longitudinal edges to form a full-circle pipe section.

In the recent past, internal inspections had been typically performed only when pipes are emptied and out of service for repairs or maintenance. Following that approach SPU inspected a short section of decommissioned pipe made of lockbar barrel, riveted joint pipe. The pipeline had been lined with cement mortar in 1949, and was therefore thought to be in good condition internally. The inspection revealed areas of concentrated corrosion along the lockbar where the cement mortar lining had spalled due to the lockbar itself.

The implication of this unexpected discovery is that corrosion along a longitudinal straight line of the lockbar would eventually create a weakened longitudinal cross section along which catastrophic failure could occur. Lockbar pipeline with corrosion along the lockbar may not fail like a typical steel pipeline with increasing incidence of small leaks. Even if external leaks do occur first, and cause the pipe to be exposed, the leak repair is unlikely to reveal much about potential internal corrosion along the lockbar. Lockbar pipe therefore warrants special attention in the near future to determine the extent of mortar spalling by internal visual inspections, and to repair or rehabilitate affected areas.

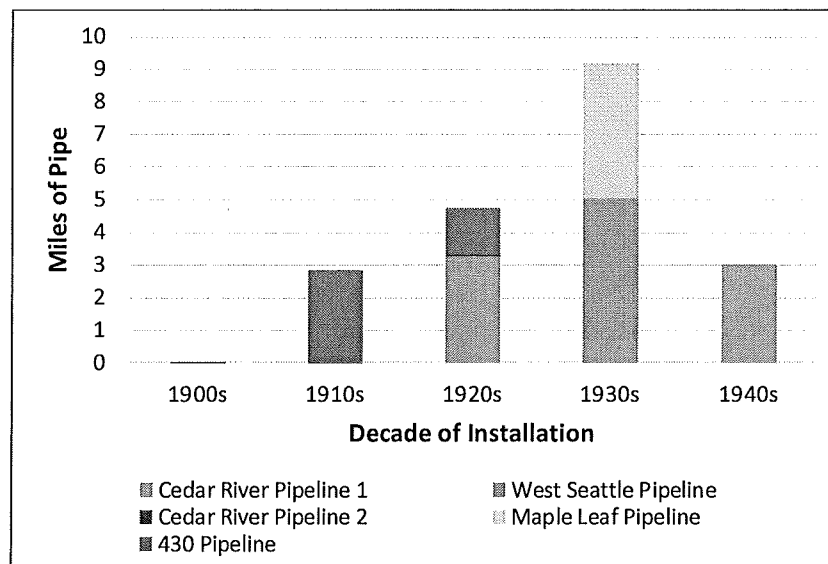


Figure 4-5. Lockbar Pipe by Decade of Installation

To that effect, SPU developed internal video inspection expertise in house, and now plans to perform systematic pro-active internal video inspections. Pipeline segments will be taken out of service and drained solely for the purpose of internal inspection. Internal video inspections of transmission pipelines are projected to be the main maintenance activity related to the pipe barrel for the next 10 years.

Lockbar pipelines will be inspected first, and to date 3.7 miles of 42-inch lockbar pipeline have been covered. The spalling problem was found to be present randomly along 25-30 percent of the length of the pipe barrel. A rehabilitation project is expected to be completed by 2020 for that particular pipeline. SPU operates 19 more miles of lockbar pipelines, and plans to internally inspect all over the next decade.

Line Valves. SPU maintains and exercises each line valve once a year to assure it operates as intended when needed. Deficiencies found are then corrected as soon as practical. The correction of some deficiencies, including replacing failed line valves that can no longer be repaired, requires the pipeline to be empty, which may take several years to procure parts for and schedule.

Air Valve Assemblies (AVAs). SPU maintains and exercises each AVA once a year to assure that it does not leak, and that air is let into the pipeline when necessary.

Blowoffs (BOs). SPU flushes and exercises each BO once a year to assure that the outlet valve off the pipeline remains operational.

4.3.3.2 Reservoirs and Tanks

Storage facility cleaning is performed to remove sediment, debris, and/or microbial growth. Cleaning is done on a scheduled basis or when water quality inside the storage has declined, as evidenced by regular water quality monitoring. The cleaning schedule is explained in the Water Quality and Treatment chapter.

4.3.3.3 Pump Stations

SPU's RCM program focuses on the function, failure mode, and criticality of a component to determine the frequency and type (i.e., preventive, predictive, or corrective) of maintenance to perform. Maintenance activities at water pump stations ensure that the stations continue to operate with minimal loss of function, thereby reducing the likelihood of customer outage, loss of pressure, and potential introduction of pathogens into the distribution systems. SPU performs three types of maintenance activities for its pump stations as described below.

Preventative Maintenance. Preventative maintenance is maintenance which is carried out on a routine basis on elapsed time schedules or equipment run-time hours. Preventative maintenance is designed to eliminate routine failures.

Corrective Maintenance. When preventative maintenance tasks or other data indicate minor equipment malfunctions, corrective maintenance is performed. This type of equipment malfunction does not restrict normal operation of the pump station.

Emergency/Reactive Maintenance. Emergency maintenance is generally carried out when a piece of equipment has failed and the need to restore its performance is critical. The criticality of each pump has been predetermined and incorporated into SPU's

computerized work management system to ensure that repair of these facilities receives higher priority than other, non-critical repairs and that critical facilities are quickly put back into service.

4.3.3.4 Wholesale Customer Meters

SPU owns and maintains 131 wholesale water meters at intertie locations with wholesale customer systems that measure usage and provide a basis for billing wholesale customers. Wholesale customer meters are 3 to 24 inches in diameter and are classified as “large meters.” SPU’s policy is to install, test, and maintain all customer service water meters in such a way as to meet the accuracy standards of the American Water Works Association (AWWA). SPU’s meter testing and maintenance practices are described below.

The most significant change to SPU’s wholesale meters since the *2013 Water System Plan* has been the replacement of lead containing brass turbine meters made by Sensus/Rockwell. Anticipated, new federal rules would prohibit the re-installation of leaded brass components in contact with drinking water once removed for any reason. SPU used to test these turbine meters by first replacing the measuring element in the field with a measuring element that has been bench tested and known to be accurate. The removed measuring element is then tested on the bench, and repaired as needed. This approach of swapping measuring elements was rendered impossible by the new lead-free brass definition which made the turbine meters untestable as test ports were not available downstream of them. Consequently, they were replaced with new battery powered electronic meters.

Meter Testing. SPU’s approach to field testing of wholesale meters varies with the type of the meter. At present, there are two types of meters on SPU’s whole sale services: compound/mechanical and electronic. The electronic meters can further be subdivided into alternating current (AC) powered and battery powered, each with a different testing strategy.

SPU tests its compound meters in the field by running the same volume of water through the meter under test and a reference meter tester, and comparing the volumes registered on each. Most compound meters are tested once a year, except the 15 highest use meters which are tested twice a year.

AC powered electronic meters are magnetic flow meters installed in the early 2000s with no test ports downstream; consequently, they cannot be tested against a reference meter. SPU contracts

with the manufacturer annually to have the meters checked and certified using electronic diagnostic tools.

Battery powered electronic meters are magnetic flow meters installed recently with test ports downstream. SPU tests them against a reference meter annually regardless of consumption.

Meter Maintenance. SPU performs scheduled maintenance activities on large meters based on a variety of criteria including manufacturer recommendations, AWWA standards and consumption history. Unscheduled maintenance activities are performed in response to billing questions and customer requests. Typically, maintenance is performed at the time of testing.

Meter Replacement. Meter replacement includes pipe work and vault modification necessary to bring meter installations up to current standards for accuracy, safety, and maintenance access, and to ensure that the impacts of supply interruptions due to meter maintenance and testing are maintained at levels that are acceptable to customers. Some upgrades may include relocation of the meter installation. Meter replacements are discussed with the customer prior to scheduling to ensure current and future customer needs are met, as well as to ensure proper meter application and coordination to limit customer impacts. Reasonable efforts are made to coordinate meter upgrade work with local street improvement projects to minimize street cuts.

4.4 NEEDS, GAPS, AND ISSUES

SPU has identified several needs, gaps, and issues for the transmission system. Needs include mitigating the risk of pipeline failure in the Tolt slide area, extending the life of transmission pipe using cathodic protection, air valve improvements for public health protection, lockbar pipe inspections and rehabilitation, and finishing up a water system seismic vulnerability study that will lead to implementing a more focused seismic capital improvement program to improve system resiliency and performance following a major earthquake. The following subsections summarize these issues and SPU's approach to addressing them.

4.4.1 Tolt Slide Monitoring and Actions

In the mid-2000's, Tolt Pipelines 1 (TPL1) and 2 (TPL2) were found to traverse through an historic landslide complex located between the Regulating Basin and Tolt Water Treatment Facility. The slow-creeping landslide had been dormant, and therefore unknown, since the pipelines were installed in the 1960s and late

1990s. However, the landslide became reactivated in approximately 2000. The slope movement has affected both pipelines: the ground in the vicinity of TPL2 has been moving 1-3 inches per year, and near TPL1 it is about one-half of that rate. Since discovery of the slide, TPL1—the much older of the two pipelines—has been very limitedly used to reduce the risk of new small joint leaks triggered by the ground movement. In addition, SPU initiated an ongoing survey and inclinometer monitoring program to track the slide and pipeline movement.

In 2009, a 48-inch double ball joint expansion sleeve was installed on the newer steel TPL2 to allow the pipeline to better accommodate slope deformation. By 2016 it was determined that the maximum distension of the joint had been reached. In July 2017, the joint was excavated and this expansion sleeve was reset to provide new range of movement for another five to ten years.

Meanwhile SPU has also conducted extensive geotechnical and seismic modeling to better understand the nature of the slide, and to assess the risk of sudden catastrophic large slope movement, especially in an earthquake scenario. The results of that work are encouraging, in that it appears a large sudden movement of the slope is highly unlikely. Ongoing slow creeping movement now appears to be the main concern.

In the context of ongoing detailed geological and groundwater monitoring, SPU is completing an options analysis that is intended to provide strategic direction for managing this problem, including any recommended capital project work.

Cathodic protection is a method used to minimize the rate of electrochemical corrosion of metallic materials, such as pipes, by shifting the corrosion process away from the metal to be protected and onto other more easily corroded "sacrificial" pieces of metal.

As noted in section 4.1 earlier, SPU has also invested in projects to protect the toe of the slope from river erosion, and to reduce the weight of material driving the slope movement. It is also of some significance that the forest atop the instability is now becoming more mature following the harvest of the upland areas sustained in the mid-1990's. This should increasingly benefit slope stability through increased evapotranspiration by trees, resulting in fewer contributions to groundwater saturation of the slope.

4.4.2 Cathodic Protection Program

SPU's transmission system consists primarily of two types of pipe, distinguished by their material and their distinct modes of failure:

- Bar Wrapped pipe can have sudden, unexpected, and sometimes destructive failures.

- Steel and ductile iron pipelines usually develop increasing numbers of leaks that are detectable and repairable well before catastrophic failure.

Failure issues associated with each type of pipeline differ because of their different failure modes and risks. Cathodic protection systems have been shown to extend the life of pipe and reduce the risk of failures for both types of pipes, as described below.

4.4.2.1 CP For Bar Wrapped Pipe

Bar Wrapped Pipe is manufactured by lining the interior of a thin-walled, steel cylinder with concrete mortar, then wrapping the exterior of the steel cylinder with steel reinforcing bar.

Bar Wrapped Pipe (BWP), also known as C303 Pipe, is manufactured by lining the interior of a thin-walled, steel cylinder with concrete mortar, then wrapping the exterior of the steel cylinder with steel reinforcing bar under slight tension enough to assure the bar is snug against the cylinder. The entire exterior is then coated with concrete mortar to provide additional stiffness and corrosion protection. BWP derives its strength from the combined strength of the steel cylinder and the spiral wound bar. However, should the bar corrode or deteriorate to the point where it can no longer take its design share of the hoop stress, the pipe cylinder can fail, sometimes catastrophically.

SPU's only sudden BWP failure due to pipe deterioration occurred in 1987 on TPL1¹. The failure caused significant flooding and property damage. Detailed investigations revealed that the failure was caused by a type of corrosion known as hydrogen embrittlement, where chemical reactions with hydrogen ions in the soil cause the steel to turn brittle and lose its strength. The chemical process is irreversible, and the only remedies are to replace the pipe or to use it as a casing and install a new, smaller-diameter, fully competent pipe inside (called slip-lining). Only the steel that was used for the spiral wrap by one particular pipe manufacturer (United Pipe) was found to be susceptible to hydrogen embrittlement. In SPU's system, all pipe made by United and prone to hydrogen embrittlement has been either replaced or slip-lined with new steel or ductile iron pipe.

Investigations in the early 1990s through dig-up inspections of the rest of the BWP pipelines revealed that these lines are still in serviceable condition although some deterioration existed. In an effort to mitigate further deterioration of BWP, SPU piloted a cathodic protection project. Cathodic protection (CP) has the

¹ A second catastrophic failure of TPL1 occurred in 1988, however that was triggered by a high-pressure surge caused by human error.

effect of arresting or greatly reducing the rate of metal corrosion in pipelines. The pilot installation proved successful and showed that a single deep cathodic protection well can protect one to three miles of concrete cylinder pipe with fairly even electric potential distribution.

The likelihood of catastrophic failure of BWP varies across pipeline sections. In some places the steel cylinder is thick enough to withstand normal working pressure even if the entire bar corrodes away. In 2012, SPU performed comprehensive analysis of its BWP transmission pipelines to determine the probability and consequence of catastrophic failure in order to best focus its CP installation efforts. It was found that most pipe sections have a steel cylinder factor of safety above 1.2, which would make catastrophic failure unlikely. Only the Tolt Eastside Supply Line was found to have significant segments with a factor of safety below 1.2, and those were then evaluated for consequence of failure.

In 2013, SPU initiated a pilot project to install a new impressed current CP system on the highest risk segment of the Tolt Eastside Supply Line (TESSL), risk being the product of probability of failure and consequence of failure. The pilot project stalled over the complexity and much higher costs related to the joint bonding, draining the pipeline for the internal work, and subsequent disinfection prior to return to service. The project was scaled back significantly and its limited success suggests that new CP installations on a larger scale for BWP are not economical at present as the pipe is still relatively new. CP remains a useful tool for managing BWP pipelines under the right circumstances, such as passive CP systems on more deteriorated short sections or individual pipe sticks.

In addition to selective use of CP, SPU plans to reduce of risks of failure in its BWP lines using the following strategies, which were identified in the *2007 Water System Plan*:

- **Develop response plans:** In the unlikely event that a failure does occur, plans are in place to respond expeditiously and repair the pipe and place it back on line, as provided in the outage service levels.
- **Stay current on new pipeline inspection technologies:** When high tech tools and methods for non-destructive, no-dig condition assessment for this type of bar wrapped pipe becomes available, SPU would be able to inspect pipe sections. After such inspections, SPU would then apply asset

management principles to decide if any should be replaced or protected with CP.

4.4.2.2 CP for Steel and Ductile Iron Pipe

Steel and ductile iron pipelines differ significantly from BWP in that they develop increasing numbers of leaks well before catastrophic failure. In most cases, leaks can be repaired without depressurizing or taking the pipeline out of service. An aging steel pipeline is more likely to present an economic concern due to its increasing repair costs well before its structural strength is imperiled.

When the incidence of leaks on a steel pipeline starts to increase, installing cathodic protection can stop further increases. SPU has used cathodic protection, coupled with internal cement mortar relining, on numerous sections of steel pipelines where either significant leaks have been experienced in the past or may be expected in the future due to corrosive soils.

Cathodic protection is a viable alternative to replacement, and in 2016 SPU developed an economic model to determine when CP is a lower cost alternative to eventual pipeline replacement. The 61 miles of older steel pipelines will continue to be the focus of the expansion of SPU's cathodic protection program for the next 30-40 years, with a goal of replacing depleted existing systems and adding new systems until full coverage is attained along the 61 miles by 2055. To accomplish this goal, SPU plans to increase annual capital funding for CP.

4.4.3 Lockbar Pipelines Inspection and Rehabilitation

The most significant new issue for the transmission system since the *2013 Water System Plan* is the unexpected discovery of corrosion along the lockbar of lockbar pipelines triggered by cement mortar spalling. Lockbar pipelines described in 4.3.3.1 are now viewed as potentially prone to catastrophic failure, causing SPU to take a proactive approach to their condition assessment and rehabilitation.

SPU has internal video inspection expertise in-house, and plans to perform systematic pro-active internal video inspections as pipeline segments are taken out of service and drained solely for the purpose of internal inspection. Internal video inspections of transmission pipelines are projected to be the transmission system maintenance focus for the next decade.

Following the inspections, each pipeline segment would likely need to be rehabilitated or replaced. At a minimum, the spalled cement mortar areas must be relined to prevent further deterioration.

4.4.4 Seismic Study and Improvements

At the time of writing this plan, SPU is anticipating completion of an update of a 1990 seismic vulnerability assessment that was performed by Cygna Energy Services. This assessment update accounts for changes in the understanding of the seismic hazards that threaten the Puget Sound region. Additionally, the 2017 update assessment emphasized pipeline performance and overall system response.

Findings to-date indicate that although some important “vertical” facilities such as reservoirs, tanks and pump stations are vulnerable, the most significant effect on water system response will be pipeline damage. Damage to transmission and distribution system pipeline damage is expected to severely disrupt system operation and delay system restoration. To mitigate the effects of this pipeline damage, SPU’s strategy will be to employ both short-term measures to manage the current vulnerability of the SPU water system and long-term measures to reduce the vulnerability of the SPU water system. SPU’s mitigation approach will include:

Measures to be implemented over next 5 to 25 years:

- Implementing isolation and control measures to mitigate the effects of pipeline damage on system-wide water pressure.
- Improving earthquake emergency preparedness and response planning to reduce recovery time.
- Implementing seismic upgrades for the most critical reservoirs, tanks, pump stations and support facilities.
- Implementing seismic upgrades for the most critical transmission pipelines through seismically vulnerable areas.

Measures to be implemented over next 5 to 50+ years:

- Upgrading one of the existing Cedar transmission pipelines to make it earthquake-resistant and increase the certainty that a minimal demand could be supplied to SPU’s direct service area following a major earthquake.
- Adopting new pipeline design standards that will specify use of earthquake-resistant pipe when pipelines are replaced in permanent ground displacement susceptible areas.

- Continuation of critical facility and transmission pipeline upgrades.

The timing for the longer-term mitigation elements will vary. Facility upgrades and construction of a seismic-resistant Cedar River transmission pipeline would be targeted for completion in 50 years. Because replacement of most distribution pipelines would only occur at the end the pipelines' useful lives, replacement of pipelines in permanent ground displacement susceptible areas would take approximately 100 years.

4.4.5 Other Upgrades and Improvements

Other transmission system needs include ongoing upgrades and improvements to air valve assemblies and pump stations.

4.4.5.1 Air Valve Assemblies Upgrades

Approximately 70% of SPU's transmission pipelines air valve assemblies (AVAs) do not meet two requirements that were not in effect when they were built. One requirement is for the air admitting orifice of the air valves to be tight-lined above ground to avoid potential cross connection. Older AVA designs place the air valves in a below grade vault, usually without drain. If the vault were to flood with ground water and/or surface runoff, and the air valve were to open due to lower pressures in the pipeline, then the potentially contaminated water in the vault would enter the pipeline. The second requirement is for a minimum of 24-inch access hole into any confined space, including underground vaults with AVAs.

SPU has an on-going capital improvement program to gradually bring its AVAs to current standards. Several AVAs are completely overhauled each year to address all mechanical, sanitary, and safety concerns. This includes replacing the air valves themselves if obsolete, tight-lining the air side of the air valves to an above-ground location to eliminate cross connection potential, replacing the vault lid to improve access, and in some cases rebuilding the entire vault when necessary.

4.4.5.2 Pump Station Improvements

Through the normal maintenance and inspection program of pump stations, SPU staff has identified deficiencies at several transmission pump stations that will be corrected through ongoing maintenance and capital improvement programs. The highest criticality stations with the highest priority deficiencies are:

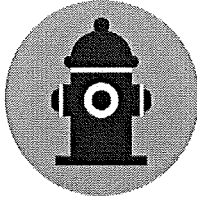
- Burien Pump Station: Contactors are obsolete; transformer is aging and is obsolete; diesel pump needs shielding (noise containment and protection from elements) or replacement with generator; and discharge valves.
- Maple Leaf Gate House/Pump Station: Piping is experiencing some significant corrosion.
- Augusta Gate House/Pump Station: Piping is badly corroded.
- Trenton Turbines: Turbines require rehabilitation.
- TESS Junction: Evaluate replacement of electric pump starter.
- Lake Youngs: Two aging PLC's.
- Eastgate Pump Station: Piping is significantly corroded.

4.5 IMPLEMENTATION/ACTION PLAN

As described earlier, the primary issues facing the transmission system for the next decade include mitigating pipeline risks in the Tolt slide area, extending the life of existing pipelines through continued deployment of cost-effective cathodic protection systems, inspecting and then rehabilitating the lockbar pipelines, and improving the seismic resilience of our water system and its pipelines. To address those and other issues discussed in this chapter, SPU has identified the following major implementation and action plan items:

- Mitigate the risk of pipe failure in the Tolt slide area through continued slope monitoring, geotechnical data collection, periodic internal inspections, and biannual leak testing, and by implementing additional capital improvements and pipeline stress relief measures when appropriate.
- Continue to implement cost-effective cathodic protection projects for older steel transmission pipelines to protect them from corrosion and extend their service lives well into the future.
- Perform internal video inspection of all lockbar pipelines, and develop a specific plan for their rehabilitation, slip-lining, or replacement, depending on pipeline condition, capacity, and seismic considerations.
- Based on the water system seismic vulnerability study, improve the overall water system's performance following a major earthquake.
- Upgrade air valve assemblies to current standards, and correct deficiencies found at pump stations.

- Continue to operate the regional water system and manage outage durations for transmission pipelines to meet service level targets.
- Remove Richmond Highlands #1 Tank from service for decommissioning.



CHAPTER 5

WATER DISTRIBUTION SYSTEM

This chapter focuses on the SPU water distribution system, the business area that involves delivery of water for retail use and for fire flow. SPU's water distribution system consists of water mains, distribution storage facilities and pump stations, and related appurtenances such as valves, hydrants, service connections, and retail billing meters. The distribution system includes assets in the retail service area shown in Figure 2-1, excluding the regional and sub-regional assets in the retail service area shown in Figure 4-1. The supervisory control and data acquisition (SCADA) system used to monitor and control the water system is also discussed in this chapter. Proper management of the distribution system ensures that SPU meets its service levels for retail customers.

5.1 ACCOMPLISHMENTS SINCE 2013 WSP

Since completion of the *2013 Water System Plan*, SPU has implemented the following improvements to the water distribution system:

- Transportation-Related Projects: Completed improvements to the water system driven by transportation projects, including the locations:
 - 23rd Ave S from East John Street to South Jackson Street, an SDOT Bridging The Gap opportunity project that involved retiring the 6 and 8 inch diameter water mains on 23rd Ave S from East John Street to South Jackson Street and replacing them with a 12 inch water main, as well as replacing the perpendicular water mains and valves in intersections that serve the cross streets (2016).
 - Aurora Ave N from N 185th to N 192nd Avenues, associated with the City of Shoreline's Aurora Ave North Project (2014).
 - Mercer and Valley Streets, as well as north-south crossings at 9th, Westlake, Terry, Boren and Fairview Avenues, associated with the SDOT Mercer East Transportation Improvements Project (2013).
 - Areas associated with the SDOT First Hill Streetcar Project (2014).

- N/NW 85th Street between 15th Ave NW and I-5 in conjunction with SDOT's Bridging the Gap project on those streets (2014).
- Areas associated with the SDOT Airport Way S ARGO bridge project (2013).
- Areas associated with the SR-99 Holgate to King Project.
- S Holgate St as part of an SDOT pedestrian project.
- Yesler Way as part of an SDOT bridge replacement project.
- Pressure Sensors: Installed new real-time pressure sensors integrated with SPU's SCADA system at three locations to replace those in fire stations that were sold by the Seattle Fire Department and to add monitoring capabilities in certain pressure zones (2013-2014).
- Water Main Replacements: Replaced about 850 feet of 6-inch Kalamein pipe on 1st Ave N between Denny Way and Thomas Street that were experiencing high leakage rates (2013).
- Fire Flow Improvements: Installed new infrastructure to improve fire flows in single-family residential areas in Arbor Heights (2012), 44th Ave SW and SW Cambridge Street (2015).
- Plastic Pipe Pilot: Replaced about one mile of primarily 8 and 12-inch cast iron pipe in corrosive soils near Seward Park with PVC pipe as a pilot to inform SPU of performance and suitability of this pipe material.
- Backbone Pipeline System Seismic Upgrades: Replaced a section of cast iron lead joint pipe in South Spokane Street between 8th Ave S and 9th Ave S (underneath the I-5 Interchange) with new 30-inch welded steel pipe, along with accompanying valve / vault seismic upgrades (2017).
- New Taps: Installed over 5,700 new customer taps from 2013 through 2017.
- Service Renewals: Renewed or replaced over 3,300 services, primarily those made of plastic tubing, from 2013 through 2017.

5.2 SERVICE LEVEL PERFORMANCE

SPU developed service levels to manage its water distribution system assets and describe what retail customers can expect of SPU in terms of water pressure and problem response. Also, a

service level was developed to limit the amount of water lost to leakage. Many of the drinking water quality service levels, as stated in Chapter 3, also apply to the distribution system. Table 5-1, below, summarizes the distribution system service level objectives and targets used by SPU to manage its distribution system assets. SPU has been consistently meeting these service level targets.

Table 5-1. SPU's Service Levels for Managing Distribution System Assets

Service Level Objective	Service Level Target
Provide adequate pressure for drinking water supplies.	- New or expanded parts of the distribution system designed to deliver peak hour demand at a minimum of 30 pounds per square inch (psi) at the meter. - No retail customers with less than 20 psi during normal operations.
Respond quickly and effectively to water distribution system problems.	90 percent of distribution system problems (emergency situations such as a pipe break; potential contamination of water supply; hydrant damage) responded to within 1 hour.
Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.	Distribution system leakage losses of no more than 10 percent of total supplied, as defined by Washington Department of Health guidelines.

Distribution system leakage (DSL) has been reported to WDOH since 2006, as required by the 2003 Municipal Water Law (WAC 246-290-820). By definition, DSL is the difference between the total amount of water produced and the amount authorized for consumption. DSL includes water lost from pipe and service line breaks, as well as from storage facilities. It also includes metering inaccuracies and unauthorized uses. Due to the location of SPU's meters, losses in the transmission system are included in the reported DSL figures.

SPU's estimate of authorized consumption consists of water sold to retail and wholesale customers based on metering data, and estimates of water used to drain and clean treated water storage reservoirs and, in past years, in overflowing of open reservoirs for water quality management. Water supplied to Volunteer Reservoir to make-up for evaporation and leakage losses have been included as an authorized use since that reservoir has been removed from service. Small amounts of water used for authorized purposes such as firefighting, hydrant testing, water main flushing, sample stand usage, and permitted hydrant usage (e.g., for building construction)

have not been included in the estimate of authorized consumption because it would be costly to meter the use, compute an estimate, or determine the amount used in a calendar year. Exclusion of these authorized uses increases the amount of reported distribution system leakage. As shown in Figure 5-1, SPU's DSL has varied from 4.9 to 6.8 percent over the past 6 years, with the last three years averaging 5.4 percent. Since 2006, the 3-year rolling average has remained below the WDOH standard of 10 percent.

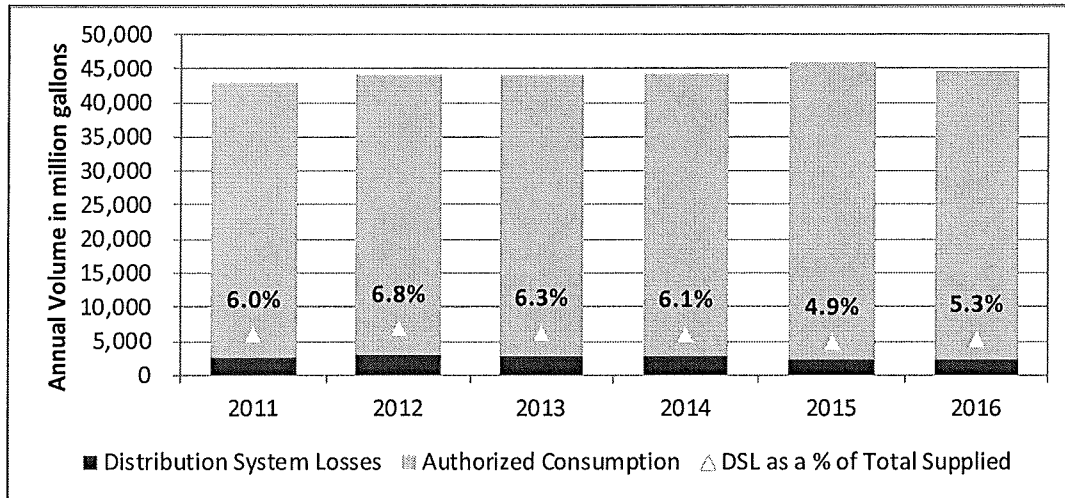


Figure 5-1. Distribution System Leakage

5.3 EXISTING SYSTEM AND PRACTICES

SPU's distribution system contains more than 1,630 miles of water mains, 6 covered reservoirs, 16 pump stations, 6 elevated tanks and standpipes, 17,000 valves, and 19,000 fire hydrants, as well as more than 191,000 retail service connections.

The water distribution system consists of the facilities that deliver treated water to SPU's retail water customers. Distribution system facilities include water mains, storage facilities, pump stations, retail customer meters, and other appurtenances. The water distribution system contains more than 1,630 miles of water mains, most of them 6 to 12 inches in diameter. Seattle's water distribution system also includes two open reservoirs that have been disconnected from the drinking water system, six covered reservoirs, 16 pump stations, and six elevated tanks and standpipes. In addition, SPU's distribution system has approximately 17,000 valves, 19,000 fire hydrants and 191,000 service lines and meters serving individual residential and non-residential properties.

Due to the hilly terrain, the distribution system is divided into 19 primary pressure zones and 26 sub-zones that are supplied by the primary zones. Pressures within these zones can vary from 25 psi to more than 100 psi (static pressure) depending on topography and how the water is delivered to the pressure zone. Approximately 65 percent of the service area, based total annual volume used, is

served by gravity, with the remainder requiring pumping. The boundaries of these pressure zones were established when the system was first developed but are subject to change as the system is further developed.

The following sections provide a description of the major classes of distribution system assets and a brief summary of their condition. The distribution system facilities O&M practices are also described, with attention given to changes in these practices or facilities since the *2013 Water System Plan*.

5.3.1 Existing Infrastructure

A description of the major components of SPU's water distribution system, a summary of their condition, and SPU's replacement/renewal strategy is summarized below. A detailed inventory of the major asset classes is provided as an appendix.

5.3.1.1 Water Mains

SPU owns a network of more than 1,630 miles of water mains within its retail service area. Since the *2013 Water System Plan*, many water main improvement projects have been completed, with a number completed in conjunction with re-development and other agency projects, such as transportation projects within the city limits of Seattle and Shoreline. However, the overall configuration of the distribution system remains unchanged since 2013.

The condition of SPU's water mains varies based on a number of factors including age, material, size, date of installation, and site-specific conditions such as soil type and corrosivity. The year of installation for water mains by decade and material type of distribution is shown in Figure 5-2. The oldest water main was installed over 125 years ago, and the average age of the is 71 years, reflecting an installation year of 1946 and the end of World War II. The oldest pipe in the system is unlined cast iron pipe, followed by lined cast iron pipe. Since the 1970s, ductile iron pipe has been installed in almost all instances.

Currently, cast iron pipe is the most common type of pipe material used in SPU's distribution system. Approximately 80 percent of the pipes are cast iron, with roughly one-half of that unlined and one-half lined. Ductile iron pipe, the current standard and most common pipe material installed since the 1970s, is the third largest material type, at 14 percent. Galvanized iron and galvanized steel each make up about 2 percent of the system. Steel pipe (wrapped, riveted, welded, lockbar) makes up about 2 percent of the system.

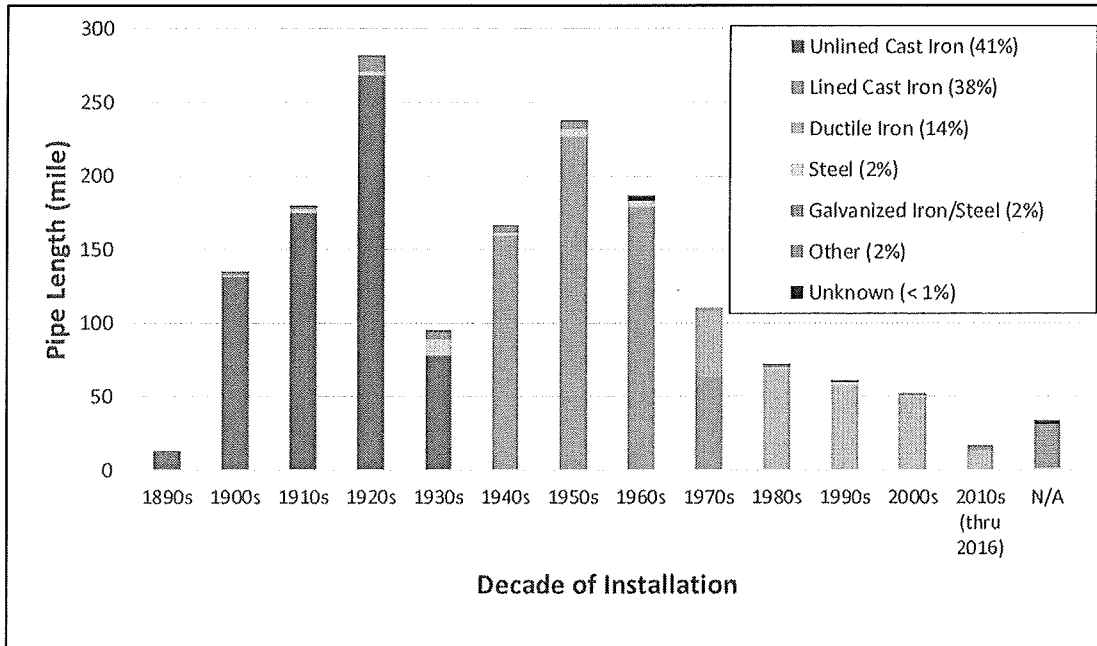


Figure 5-2. Type of Material and Decade of Installation for Water Mains

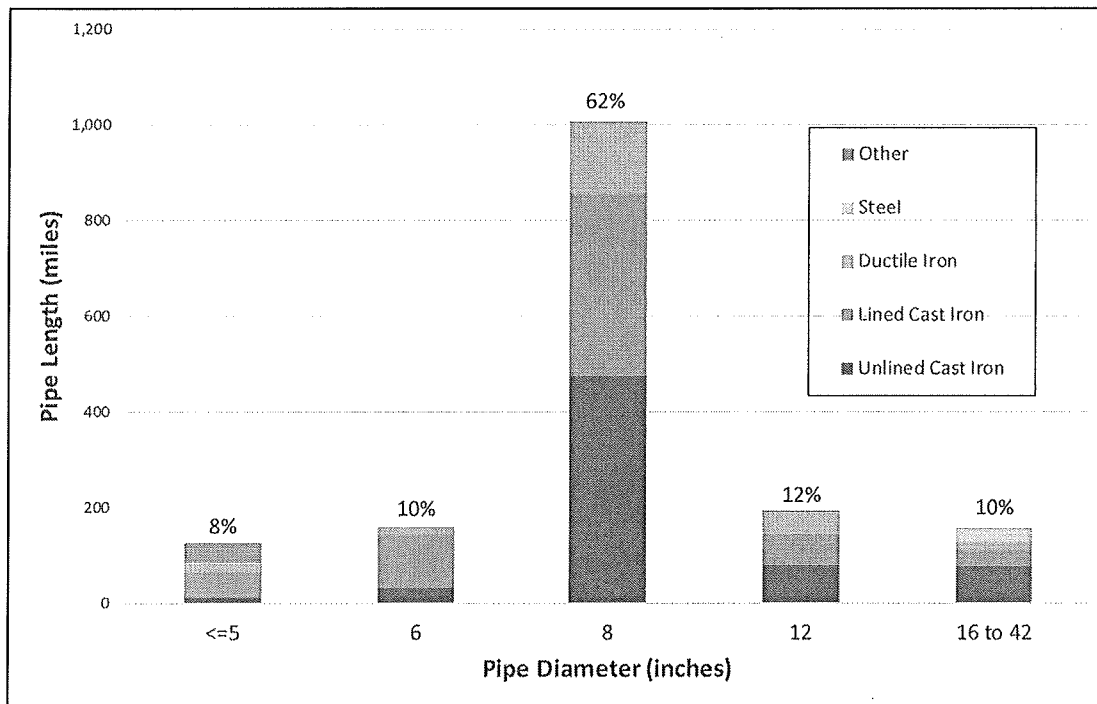


Figure 5-3. Pipe Diameter and Material Types for Water Mains

The remaining pipe is made of other materials, including concrete cylinder, polyvinylchloride (plastic) and copper. There is no asbestos pipe in the system according to SPU's records.

Figure 5-3 provides a breakdown of material types by pipe size. As indicated by the figure, the majority of pipe, or approximately 62 percent, is 8 inches in diameter.

SPU does not have specific condition assessment information for most of the distribution system water mains. Without specific condition assessment data, the condition of the water mains is based on the pipe material, soil type, age and number and types of leaks and breaks. Based on data from 2000 through 2016, the rate of water main leaks and breaks remains low, averaging 9 reported leaks or breaks per 100 miles per year in the distribution system. This is less than the rate experienced by most other major water utilities in the United States¹.

Not all leaks or breaks require water service delivery outages. However, if a repair does require an outage, it is considered unplanned. Distribution system improvement projects can also lead to planned or scheduled outages. Approximately one-half of all outage events were unplanned, and one-half were planned. In 2016, fewer than 1 percent of all customers experienced water service delivery outages of more than 4 hours per year from all planned or unplanned events.

5.3.1.2 Distribution System Water Storage Facilities

SPU's distribution system includes six in-city reservoirs and six elevated tanks and standpipes to provide operating and standby storage capacity to its retail customers. The amount of storage is provided in the appendices.

Distribution System Reservoirs. SPU currently operates and maintains six active reservoirs in the distribution system. Lincoln, Myrtle and Beacon Reservoirs have been recently replaced with below grade reinforced concrete tanks. Two additional open reservoirs, Volunteer and Roosevelt, have been taken out of service, as noted in Chapter 3, and the outlets have been disconnected from the distribution system. However, the inlets are still connected, and at Volunteer, where water is still impounded, the reservoir level is kept below the inlet elevation to establish an air gap. These reservoirs may be used for emergency non-potable

¹ Neil S. Grigg, 2007, *Main Break Prediction, Prevention, and Control*. Report 91165. AwwaRF and AWWA.

storage for post-earthquake or other emergency response, and/or eventually returned to service as covered reservoirs if future water system needs require it.

Condition assessment of in-town reservoirs follows the same procedure as described for the water transmission system reservoirs. Based on inspections, the structures are in good condition. When tested in 2009 and 2016, the leakage rate at Magnolia Reservoir was negligible. The leakage rates from Bitter Lake and View Ridge Reservoirs were low and estimated to be 1.09 and 3.8 gpm/MG, respectively, when tested in 2016. Beacon, Lincoln and Myrtle Reservoirs have not been tested since they were replaced.

Distribution System Elevated Tanks and Standpipes. In addition to its in-town reservoirs, the SPU water distribution system includes one elevated tank and five standpipes. The elevated tanks and standpipes were constructed between 1907 and 2008. They range in capacity from 0.9 mg to 1.9 mg. Barton Standpipe was decommissioned in 2012 after its bypass was completed. SPU is planning recoating projects for Volunteer Standpipe, and Trenton North and South Standpipes.

Distribution system tanks and standpipes are inspected and maintained in the same manner as transmission system tanks, as described in Chapter 4.

5.3.1.3 Distribution System Pump Stations

SPU operates 16 distribution system pump stations with a total of 36 individual pump units. These pump stations are inspected regularly to ensure that they continue to function properly and equipment is repaired or replaced as needed. Distribution system pump stations are maintained in the same manner as transmission system pump stations, as described in Chapter 4.

5.3.1.4 Distribution System Appurtenances

The SPU water distribution system includes a number of smaller appurtenances, such as valves, hydrants, service lines, and meters. The paragraphs below summarize SPU's inventory and replacement approach for each class of appurtenance.

Distribution System Valves. SPU's water distribution system includes more than 17,000 valves. Most valves are line valves which function to reconfigure the flow of water through the distribution system as needed, while other valves regulate pressure

and flow, provide for bypassing of facilities, or allow air to escape the system.

Distribution appurtenances include various parts, features and elements that are incidental, integral, or subordinate to the system, such as valves and hydrants.

SPU asset management approach focuses attention on assessing the condition of critical valves and conducting preventative maintenance or corrective repairs, based on condition. For non-critical valves (valves that isolate flow on non-critical water mains), repairs are initiated as needed when defects are noted during valve operation. Valve replacement is initiated when the repair or resolution of a defective condition is impossible, or would cost more than valve replacement. Valve replacement also occurs when distribution mains are replaced or relocated.

The valve chamber replacement program will continue through the next several years. This program replaces existing chamber lids and access maintenance holes with larger diameter lids and new access ladders. This program will provide SPU maintenance staff with safer valve chamber access and meet industry safety standards.

Distribution System Hydrants. SPU maintains 18,664 fire hydrants. Annual condition assessment of fire hydrants is performed by various fire service agencies operating in Seattle's retail service area¹. Damage to fire hydrants is also commonly reported between routine condition assessment cycles.

SPU resolves problems observed and reported by the fire service agency and the public. Problems are categorized into two levels. First, problems that make a hydrant unusable or unsafe to use are given the highest priority to repair or replace. Second, problems such as minor leaks that do not affect a hydrant's availability for firefighting and main flushing are given a low priority for repair or replacement. SPU's hydrant replacement strategy for obsolete hydrants is to replace these hydrants in areas when other water system projects are being constructed and where excavation costs are low and future costs are likely to be much higher. Other than these "opportunity projects," SPU replaces hydrants that are found to be inoperable and repairs are not possible or exceed the cost of replacement. New hydrants may also be installed as part of new development.

¹ Fire departments with jurisdiction in Seattle's retail service area include the Seattle Fire Department, Shoreline Fire Department, Northshore Fire Department, North Highline Fire District, Burien / Normandy Park Fire Department, and King County Fire District 20.

Distribution System Service Connections. SPU has more than 191,000 retail service connections, an increase of more than 5,200 services since 2013, mainly for new residential customers. The number of new service installations has increased at an accelerated rate since 2013 largely due to substantial new residential development projects throughout the City. Most of the services (86 percent) are for residential customers, almost 12 percent are for commercial customers, and the remaining 2 percent are for fire service. The majority of service connections, 58 percent, are 3/4-inch diameter pipes. Currently 78 percent of service lines are copper and 13 percent are plastic. The remaining 8 percent are made of other materials.

Service lines made of plastic or galvanized steel are more susceptible to failure and are now no longer used. Prior to 1947, all of the service lines were made of galvanized steel, and these have been primarily replaced with copper. Between 1968 and 1984, SPU installed or replaced approximately 40,000 small services (3/4-inch to 2-inch) with plastic tubing.

Prior to 2003, SPU's approach to renewal of small water service lines was "fix when fail." The cost of this primarily reactive strategy for some services has been high in both SPU's direct repair cost and social impact costs, such as damage to customer property, roads, and the environment. In 2003, a plastic service renewal pilot program began whereby blocks of plastic services were proactively renewed. In 2005, the programmatic approach was modified from block renewal to critical service renewal whereby plastic pipes with high risk costs were identified and renewed first.

The current water service renewal program consists of both reactive and proactive components and is described more fully in Section 5.3.3.4. Replacement of lead whips is described in Chapter 3.

Distribution System Meters. Each service line is fitted with a water meter used to determine customer consumption and charges. Nearly 92 percent of SPU meters are small (3/4-inch and 1-inch).

SPU has installed approximately 3,000 automated meter reading (AMR) radios on difficult-to-read meters. This form of automated meter reading (AMR) allows these meters to be read safely and efficiently in walk-by or drive-by mode. Examples of where AMR is cost-effective and used at SPU include:

- Meters that are a safety hazard and/or require costly setup to read visually, mostly due to being located in an area with traffic hazards.
- Clusters of meters located in larger vaults with heavier lids, which pose an injury risk to meter readers when repeated frequently.
- Meters located in parking areas that are unreadable when a vehicle is parked over them, leading to frequent estimated bills.
- Meters that tend to get buried and/or overgrown and require frequent clearing.
- “Deduct” meters owned by the customer and located on private property in hard to access locations, leading to lengthy time required to get a reading.

5.3.2 Operations

SPU’s water distribution system is primarily served by gravity, but pumps are used to serve some pressure zones. To control flow and storage levels, SPU water system operators at the Operations Control Center operate pump stations, valves and other water system components using the remote control capability of the SCADA system or by directing crews to locally operate field equipment. The current SCADA system, which was installed in 2006, provides real-time data regarding pressure, flow, storage facility water level, and pump/valve status to system operators. Archived SCADA data are also useful for hydraulic network modeling, system planning, and engineering design.

In addition to the control room at the Operations Control Center, SPU has a backup control room at the SPU North Operations Center. The backup control room has been improved to substantially reduce start up time to begin system monitoring and control from that location.

Additional information on system operations, particularly the Operations Planning and Scheduling function, is provided in the appendix for Water System Management and Operator Certification.

5.3.3 Maintenance

Proper maintenance of distribution system components ensures that SPU will be able to deliver reliable water service by reducing

the risk of unexpected failures. Summaries of maintenance activities for the distribution system are provided below.

5.3.3.1 Water Mains

The most significant maintenance for water mains is leak assessment and control and water main repairs. The 2000 through 2016 water main break/leak data indicate that approximately 103 to 168 water main failures (leaks and breaks) occur each year, with an average of 135. This excludes leaks on other appurtenances, such as water services and water mains, that result from damage attributed to third parties. Approximately one-third of the failures, however, are joint leaks which often do not require a complete water main shutdown. Also, repair of leaks from corrosion-related pinholes do not usually require complete shutdowns. Small water main leaks can be repaired “live” by throttling adjacent valves and temporarily reducing the feed to the water main segment being repaired. Only larger breaks typically involve a complete water main shutdown. When this is the case, routine shutdown practices are used. These include controlled release of water, vacuum relief at higher portions of the affected pipe segment, and maintaining positive pressure at the repair site until the broken pipe is exposed and decontaminated.

Reports of potential water main leakage require immediate response. Prompt investigation and preemptive valve operation can prevent distribution system pressure loss when apparently minor leakage progresses to a more serious main break. SPU has implemented a Field Operations Mapping System with automatic vehicle location capabilities to quickly dispatch the nearest equipped crew/vehicle to address a problem. Improvements to SPU’s work order management process have also been implemented. SPU distribution staff has been consistently meeting the service level target for problem response (90 percent problems responded to within one hour).

Other water main maintenance practices include water main flushing. Additional information on water main flushing is provided in Chapter 3.

5.3.3.2 Reservoirs and Tanks

Storage facility cleaning is also performed to remove sediment, debris, and/or microbial growth as described in Chapter 3.

5.3.3.3 Water Pump Stations

Pump stations in the distribution system are maintained in the same manner as described for the transmission system pump stations in Chapter 4. The asset management approach used by SPU to optimize pump station inspection and repair is Reliability Centered Maintenance (see Section 4.3.3.3).

5.3.3.4 Water Appurtenances

SPU also performs maintenance activities for its valves, hydrants, service lines, and meters to ensure their continuing operation. A brief description of each follows.

Valves. Between 2006 and 2016, SPU responded to an average of 118 valve-related problems per year, or approximately 1 percent of all valves. Most valve problems can be categorized as leaks, casting failures, mechanical inoperability, and valves being buried by new pavement. Deterioration of interior packing, broken and bent stems, and construction projects are usually the causes of valve problems.

Due to a shift in priorities, the routine operation work of exercising critical valves is performed less frequently than in the past (prior to 2003). There have been no demonstrated negative impacts from this reduction in routine exercising. However, drinking water utilities throughout the country and the industry as a whole have largely demonstrated that valve failure probability increases substantially over time if routine exercising is neglected. SPU intends to resume and accelerate critical valve preventative maintenance as resources become available.

As part of the Shutdown Block Analysis described in the *2013 Water System Plan*, a GIS layer has been developed to help identify the need for new isolation valves, or relocation of existing isolation valves. Cost-effective system improvements can then be implemented as opportunities arise (e.g. third-party projects or asset failure).

A Valve Asset Management Plan was developed in 2015, which included an update to valve maintenance, replacement, and renewal strategies. The AMP documented a substantially improved criteria for identifying critical valves whereby criticality criteria is based on more comprehensive water system impacts. These criteria were expanded beyond the typical criticality designation derived from adjacent (connected) water pipe diameter. Another notable advancement in SPU's valve

management was the plan for reimplementing a valve inspection and exercising program, which will reduce overall maintenance and capital costs and provide a more reliable and effective means of controlling the water distribution system.

Hydrants. Each fire service agency inspects hydrants located within its service area, generally on an annual basis. Defects are reported to SPU for repair. In 2016, SPU responded to approximately 1,500 work orders to address fire hydrant defects.

SPU updated the Hydrant AMP and associated maintenance strategy in 2017. The AMP also included a strategy and timeline for completing a substantial backlog of unresolved hydrant maintenance work orders. This strategy adds a task to all hydrant maintenance work orders to paint hydrants when needed and during amenable weather conditions. An optimal hydrant painting program driven by an 8-year painting rotation will begin when funding and crew resources become available at a future date.

Service Connections. Maintenance related to service connections includes leak investigations, minor repairs on service lines, and replacement of broken valves, rods, or fittings. SPU's water service renewal program consists of both reactive and proactive components:

- **Reactive renewals** include asset failure renewals due to emergency or non-emergency breaks, leaks, or mechanical failures (shutoff valve or meter failures), typically reported by customers. Reactive renewals called "demand renewals" are also identified by SPU staff when other projects trigger the need for a service connection replacement, such as during water main relocation/replacement, service upsizing/downsizing, or "companion" renewals (substandard service pipes located in the same trench as another excavated water asset, which would likely fail during backfill and compaction).
- **Proactive renewals** include opportunity renewals and critical renewals. Opportunity renewals are performed when other projects, typically transportation-related projects, are restoring street pavement at no cost to SPU, which can be as much as 40 percent of the total cost to replace service connections. Critical renewals target small services where the remaining life is projected to be short and the consequences of a break would likely be significantly higher than typical. For example, a "critical" site may be in a steep slope or landslide area, or in

high volume traffic roads offering few options for detouring traffic.

In addition, SPU has observed through practice that proactive service retirement is not cost effective, and, therefore, most service retirements are carried out reactively, except for opportunity renewals. Inactive service pipes are typically retired when leaks develop, new services replace the obsolete service, or the unused service is in conflict with or is abandoned with new right-of-way improvements or water main work.

Meters. SPU's retail water meters ensure proper billing for water use as well as for wastewater services. Meter problems may be identified at the time of meter reading, such as when broken meter dials are found, or by the billing system, such as when consumption is much higher or lower than what is expected for a customer based on historical information. Metering issues may also be discovered when customers inquire about unusually high bills. Such issues may lead to testing, repair or replacement of a meter depending on its size and customer class.

SPU has a meter testing and maintenance program for its large meters, which represent less than three percent of all retail meters. SPU's goal is to maintain accuracy of large meters to between 97 and 103 percent as per the guidelines of the American Water Works Association. A large meter with an accuracy falling outside that range is either repaired to restore its performance or replaced. In 2009 and 2010, SPU replaced approximately 125 large retail meters per year. The pace of the replacement program has since slowed since the older large meters with consumption sufficient to justify a proactive replacement have already been replaced. At present the large meter exchange program is largely reactive, replacing obsolete meters when they fail. For retail services this typically does not result in revenue loss as they have a well-established water use pattern that can be used reliably to estimate consumption for the billing period(s) when the meter was not functioning.

In the 2008-2012 period SPU piloted the use of electronic large meters, and found them superior to their mechanical counterparts in terms of low flow accuracy, reliability, and level of O&M. Electronic meters do not benefit from periodic testing as they have no moving parts to degrade their accuracy, which lowers routine maintenance costs. On the other hand, they are battery powered, with estimated battery life of 12-15 years at most.

In 2012 SPU standardized on ultrasonic large meters, and has since then been using them for all new retail services, as well as for

failed existing meters in need of replacement. The brand and model currently in use by SPU may not provide for a battery replacement while the meter is installed in the field; at present meters with drained batteries must be removed and shipped back to the manufacturer for battery replacement, which causes significant SPU labor costs, as well as some customer impact. SPU is experimenting with developing in-house expertise to replace depleted batteries while the meter is installed on the service.

However, if that approach does not work out as hoped, it is expected that in 2023-2025 period a new meter replacement workload will gradually arise to replace large meters with drained batteries. While by then most of the legacy/obsolete mechanical meters would have been replaced, this new workload could keep the overall meter replacement program at a level close to current.

SPU does not typically perform maintenance activities for small meters since repairing small meters is not cost-effective and it is generally less expensive to replace a small meter than repair it. SPU reactively replaces less than one percent of its small meters per year when they fail or when a service is renewed for other reasons. SPU continues to use multi-jet mechanical meters for its small meter needs, and has found them very reliable, durable, and with little or no accuracy degradation over the life of the meter.

Existing meters may be retrofitted, or new meters may be equipped, with radio units for AMR to allow walk-by meter reading when more cost-effective than visual reading. AMR system maintenance involves replacing failed radios or encoded registers as needed.

5.3.3.5 Record Keeping and Reporting

SPU has a number of tools to track and report on water distribution assets. SPU uses its MAXIMO work management system to capture asset failure and maintenance history. SPU also uses a geographic information system (GIS) to record and display locations of physical assets and problems. This tool is also used to review shutdown blocks, gridding and hydrant spacing, identify critical assets and develop asset management strategies.

5.3.4 Asset Management Planning

As noted Chapter 2, important asset management planning documents that SPU uses include asset management plans (AMPs). The Distribution System business area is the most asset-intensive of the business areas for the drinking water system. SPU has

prepared a number of AMPs for major classes of distribution system infrastructure components, including the following:

- Water Distribution Pipes (2018)
- Water Pump Stations (2006), with Reliability Centered Maintenance recommendations implemented in 2011
- Water Valves (2015)
- Water Distribution Hydrants (2017)
- Water Distribution Service Pipes (2004)
- Water Distribution Meters (2004)

Updates to the Water Distribution Hydrants AMP and Pipes AMP were recently completed, and the Meters AMP will be updated next.

5.4 NEEDS, GAPS, AND ISSUES

The primary needs, gaps, and issues facing SPU's distribution system in the coming years are related to distribution system assessment and planning, seismic improvements aimed at improving system resiliency and performance following a major earthquake, and other projects including fire flow, pump station upgrades, and opportunities presented by third-party projects related to transportation and redevelopment. The following subsections summarize these needs and SPU's approach to addressing them.

5.4.1 Distribution System Assessment and Planning

In recent years, SPU developed asset management plans, conducted water main condition assessments, and completed shutdown block analyses, which have resulted in a number of findings and strategies for the distribution system.

5.4.1.1 Water Distribution Pipes Asset Management Plan

A Water Distribution Pipe AMP was recently completed to refine SPU's water main rehabilitation and renewal strategies. The AMP includes the development of a risk profile using software that analyzes data contained in SPU's GIS to quantify specific risks, assesses how specific risks compound for each water main, and ranks all water mains based on total risk score. Risk is the product of likelihood of failure and consequence of failure. This ranking is then used to develop programs for water main rehabilitation,

renewal, inspection and condition assessment. Risk based decision making is a water utility industry standard for asset management.

Rehabilitation and renewal strategies are investments used to reduce cost and risk and enhance benefits by selectively refurbishing or replacing existing assets. These strategies are generally capital projects: pipe lining, adding cathodic protection, or replacing the water main with a new pipe either in the same location or in another alignment.

Implementation of these rehabilitation and renewal strategies will require greater investments by SPU than what has been spent in the past. Use of the new risk model allows SPU to better focus these investments on high risk water main assets.

5.4.1.2 Water Main Condition Assessment

Parts of SPU's water distribution system, in particular many of its pipes, have been in place for more than a century. Although the existing system is in good condition, as evidenced by its low leakage and failure rates, SPU has limited information about the condition of water mains. High risk pipes, which meet threshold criteria will undergo water main condition assessment, if feasible. The threshold criteria is under development.

SPU plans to increase water main inspection programs as resources become available to better monitor and assess water main conditions. Inspection methods under evaluation include:

- More focused visual inspection programs for high risk water mains that are physically accessible and for which a visual inspection is feasible (e.g. water mains attached to bridges and roadways or located in utilidors).
- More frequent water main condition data collection when SPU crews dig up and expose water mains in the distribution system while completing other work.
- More proactive leak detection, using acoustic leak detection equipment and technologies described below, to monitor water mains with high risk.

As noted in the *2013 Water System Plan*, SPU conducted in 2007 a leakage test of Cedar River Pipeline 2 from Volunteer Reservoir to Maple Leaf Reservoir (also known as the 430 Pipeline) using Pure Technologies SmartBall technology to assess its condition. This initial phase of a leak detection pilot was successful. In 2015 and 2016, SPU conducted two field demonstration projects using Pipeline Inspection and Condition Analysis Corporation's (PICA)

“SeeSnake”, a remote-field electromagnetic technology to scan pipe wall thickness of cast iron pipelines in corrosive soils. The 2015 and 2016 field demonstration projects were successful.

These technologies as well as other technologies are under consideration as pilot programs to ascertain the condition of water mains by assessing for leaks and/or remaining pipe wall thickness. If water mains are found to be in need of repair, they will be repaired or given a high priority for capital investment to rehabilitate or replace prior to pipe failure. This evaluation will be based on asset management principles.

5.4.1.3 Shutdown Block Analysis

As described in the *2013 Water System Plan*, SPU has completed a shutdown block analysis in which each pipe segment in the retail service area was evaluated to determine the service delivery impact if that pipe segment is taken out of service. In this context, service delivery impacts are based on the number of customers and the number of hydrants.

Pipe segments associated with High Impact Shutdown Blocks (HISB) are identified on a GIS layer, as are the associated outage areas. The HISB GIS layer is used during the planning phase of water main replacement projects, redevelopment and third-party projects to reduce the size of these potentially large outage areas. Mitigation measures typically involve additional gridding of distribution mains and installation of additional line valves at existing grid junctions. The HISB GIS layer also informs the crews who plan and execute shutdowns for routine and emergency work, which prevents inadvertent initiation of an unusually large service outage.

The analysis of high-impact shutdown blocks has also resulted in changes to SPU’s Design Standards and Guidelines to place greater emphasis on outage management in water main design and valve placement.

5.4.2 Seismic Study and Improvements

SPU’s seismic study was described in Chapter 4 – Water Transmission System. Many of the seismic improvements that are being considered are for distribution facilities. Improvements to distribution system facilities include isolation systems that could be used to prevent heavily damaged areas from draining less damaged areas, upgrading the most critical reservoirs and pump stations, and using earthquake resistant pipe when pipelines are

replaced in areas subject to permanent ground displacement. Soil liquefaction in the Duwamish Valley poses one of the key seismic vulnerabilities for SPU's distribution water mains. Landslide areas present another vulnerability.

Replacement of distribution water mains in soil liquefaction and landslide-prone areas with seismically resistant pipe can be cost-effective when the water main needs to be replaced for other reasons, such as the end of useful life or when third-party projects require relocation of the water main. For example, previous seismic upgrades in the Duwamish River Valley area occurred when SPU took advantage of opportunities created by Seattle Department of Transportation (SDOT) projects. SPU plans to continue to take advantage of opportunities to accomplish replacements of older water main with new earthquake resistant pipe in seismically vulnerable areas as they present themselves.

5.4.3 Other Distribution System Upgrades

SPU has a large capital program for distribution system improvements. This program is used to identify, prioritize and fund seismic upgrades and fire flow and pressure improvements. The program may also consider cleaning and lining as an option for making system improvements in areas with unlined cast iron pipes. These aspects of the distribution system improvement program are described in the following subsections.

5.4.3.1 Fire Flow Improvements

Although the majority of the SPU's hydrants are able to deliver more than adequate flows to combat fires, there are areas inside and outside of the City of Seattle where SPU's water system has hydrants that cannot deliver fire flows to existing buildings under current codes required for new buildings. This can be caused by a combination of factors including pipes with small diameters or areas with low water pressure due to older design standards, or pipes whose interiors have been reduced by deposits. There are also areas that were originally built to now obsolete fire codes.

Although SPU is not legally obligated to upgrade the existing system to meet current standards, SPU's distribution system is upgraded to current fire flow standards as needed for development/redevelopment and as other system improvements are made (see section 5.4.5).

In 2011-2012, SPU conducted a system-wide hydraulic network modeling analysis to determine available fire flow under average

day demand conditions. Based on this analysis, SPU constructed fire flow improvement projects at nine locations from 2012 through 2016: Arbor Heights, 24th Ave S, 50th Ave SW, Blue Ridge, Capitol Hill, Madison Park, North Admiral, SW Cambridge St, and Burien Shorewood. These improvements consisted of over 5,000 linear feet (LF) of water main replacements, over 4,000 LF of water main cleaning and lining, and several new pressure-reducing valve stations.

SPU's distribution system contains approximately 700 miles of unlined cast iron pipes. As these pipes age, many exhibit varying degrees of tuberculation that increases the pipe wall roughness inside of the pipe, thereby increasing resistance to water flow which reduces pipe flow capacity, lowers the pressure of water delivered to customers, impacts fire flow capabilities, increases pumping costs, and can cause water quality problems. In its options analysis to address fire flow in the distribution system, SPU will continue to consider the use of cleaning and lining as an alternative to replacement of deteriorated unlined, cast iron pipe.

In 2017, SPU conducted an updated fire flow hydraulic modeling analysis under maximum day demand conditions. This analysis, which is summarized in the appendices, identified additional areas for potential fire flow improvement projects.

5.4.3.2 Pump Station Improvements

A number of distribution system pump station deficiencies have also been identified by SPU staff. The highest priority deficiencies at the most critical stations are:

- Spokane Street Pump Station: Structure is failing; floor structural timbers have rotted out in some locations; roof is leaking; electrical equipment is obsolete and/or does not meet code; low voltage panel; medium voltage transformers.
- Broadway Pump Station: Obsolete oil pump contactor.
- West Seattle Pump Station/Gate House: Piping is badly corroded.
- Lincoln Pump Station: Piping in bypass chamber is significantly corroded.
- Volunteer Pump Station: Obsolete contactors.

5.4.4 Third-Party Projects

Other agencies, utilities and private developers construct projects in the retail service area that can impact the distribution system. These third-party projects often necessitate SPU to make system changes that it would not otherwise do, but they can also present opportunities for improving flow capacity, pressure, reliability, and water quality in the distribution system at a reduced cost to SPU ratepayers. The following sections describe the impact on the distribution system from transportation projects and new development.

5.4.4.1 Transportation Projects

Transportation projects are third-party projects that can have a significant impact on the water system because of the need to relocate or protect existing water infrastructure. Also, transportation projects often create opportunities to renew or upgrade water infrastructure assets at a lower cost by taking advantage of the street opening and reducing pavement restoration costs. The impact of transportation projects on the water system continues to grow as the region invests in new transportation infrastructure.

SPU considers whether to relocate or retire water infrastructure for transportation projects when the existing water infrastructure would not be able to remain in its existing location due to grade conflicts, would no longer be accessible for maintenance and repair, would have increased consequences of failure after the transportation improvements have been built, or would have a high probability of failure due to damage during construction that cannot be remedied by protection measures. Water infrastructure may be retired when it is not needed for water delivery to specific water services or fire hydrants, for the delivery of fire flow to the surrounding area, and for delivery of water to surrounding areas such as usually provided by feeder mains. Water main gridding is also considered in water main decisions as a way to mitigate the impacts that dead-ends have on the system, such as to water quality and shutdown block size. Distribution mains that cannot be retired but are smaller or larger than the standard pipe sizes (8-inch for single-family residential areas and 12-inch for industrial and commercial areas) are evaluated for proper sizing prior to relocation. The evaluation usually involves hydraulic modeling of the present-day water system configuration and expected future uses and densities.

If water infrastructure does not need be relocated and is not slated for retirement, SPU may choose to protect it in place or take the opportunity to renew or upgrade it. SPU has developed guidelines for impact and opportunity-driven asset replacements for transportation projects. These guidelines are based on the type and condition of the asset and the type and size of the impact (or opportunity). The water main may be replaced in kind, upsized or downsized depending on current and anticipated capacity requirements.

The extent of transportation improvements in Seattle's retail service area by Sound Transit, Washington State Department of Transportation (WSDOT), Seattle Department of Transportation (SDOT), and the City of Shoreline is expected to remain high at least through the first ten years of the planning period, with the larger projects being as follows:

- SR99 Improvements through downtown Seattle by WSDOT, including new tunnel construction and demolition of the existing Alaskan Way Viaduct.
- Seattle Central Waterfront Redevelopment by SDOT.
- Center City Streetcar by SDOT.
- Sound Transit light rail projects, including the Northgate and East Links and Ballard and West Seattle Link Extensions.
- SR520 highway replacement, and improvements to the I-5/SR520 interchange by WSDOT.
- Approved by voters in November 2015, the 9-year, \$930 million Seattle Department of Transportation Levy to Move Seattle provides funding to improve safety, maintain Seattle's streets and bridges, and invest in reliable, affordable travel options. The program is creating very significant impacts to SPU's water infrastructure in the street right-of-way, especially the arterial street resurfacing and reconstruction components. However, it is also presenting some opportunities for SPU to replace aging water main infrastructure.

Because these transportation projects are led by third-parties, the schedule for completion is not within SPU's control and is subject to change.

5.4.4.2 Redevelopment

Redevelopment activities can have a substantial impact on the ability of the existing distribution system to provide sufficient water to customers and for fire flows. Rezoning can also change

distribution system requirements, particularly when single-family residential parcels are rezoned to mixed or commercial uses. Most often, extension of the distribution system or improvements to existing water mains in the redeveloped area becomes necessary to provide water service to new dwellings, more densely arranged, on streets previously occupied by low-density housing and larger lots. Frequently, the required water main extensions promote better system gridding, which has the effect of improving fire flows and looping existing dead end mains. Detailed hydraulic models or hydrant flow tests are used in conjunction with fire flow requirements provided by the fire department¹ to identify potential water main improvements when properties are redeveloped, as well as when new development takes place.

New developments must meet the current fire code, and new service connections must be made to suitable water mains. SPU reviews and provides a water availability certificate for each development as part of the local government's building permitting process (see appendices for SPU's policies and procedures for new services). If there is a gap between what the existing system can provide and what the private development needs, the developer will be required to upgrade the existing system to meet requirements. Developers are required to pay for connection to the system. New tap installations are directly billed to the customers.

5.5 IMPLEMENTATION/ACTION PLAN

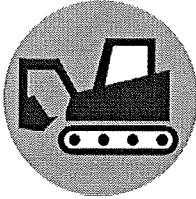
As described in this chapter, the major needs for managing the distribution system to meet service level targets include asset management planning, distribution system assessment and planning, addressing the performance of the water system following a major earthquake, and opportunities presented by third-party projects such as SDOT's Move Seattle program. SPU has identified the following actions to address these needs:

- Manage retail service delivery, problem response and leakage to meet service level targets.
- Improve operational response and customer service by using information from the water main shutdown block analysis in project and emergency shutdown plans.

¹ See footnote on page 5-10 for fire departments with jurisdiction in SPU's retail service area. For the City of Seattle, fire flow requirements are defined by the Seattle Fire Code (SMC 22.600). Fire flow standards for unincorporated King County are defined by KCC 17.04 and 17.08.

- Update asset management documents, including the Meters AMP, and implement the strategies identified therein.
- Continue to proactively replace or rehabilitate water mains based on risk profile including leak/break history.
- Resume critical valve preventative maintenance and exercising program (updated via Valve AMP) to ensure adequate and reliable control of the water distribution system grid.
- Based on the water system seismic vulnerability study, improve the overall water system's performance following a major earthquake.
- Continue to work with the Seattle Fire Department and Shoreline Fire Department to improve fire hydrant maintenance and testing practices, better coordinate communication, and prioritize fire flow improvement projects. Engage in similar discussions with other fire districts.
- Include proactive hydrant painting tasks in all hydrant maintenance work orders to paint hydrants when needed and during amenable weather conditions.
- Correct deficiencies found at pump stations.
- Continue working with developers where water main replacements or upgrades in redevelopment areas are required to meet current fire flow requirements and water main standards.
- Address impacts to the water system from transportation projects, particularly Move Seattle levy and Sound Transit projects.

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CHAPTER 6

CAPITAL IMPROVEMENT BUDGET

Previous chapters describe SPU's drinking water CIP projects and O&M programs and identified a number of needs, gaps, and issues facing SPU in each of its business areas. This chapter focuses on the budget required to implement capital programs to meet SPU's regulatory and customer service objectives, including addressing the needs and gaps. The first part of the chapter begins by describing SPU's process for developing a capital improvement budget for the water system. Later, the chapter identifies the budget for the 10-year capital improvement program (CIP) and capital facilities plan (CFP) through 2040 for the water line of business, along with potential additions to the CFP.

6.1 CAPITAL IMPROVEMENT BUDGETING

SPU uses an asset management approach in selecting which capital improvement projects go forward. Asset management is a method of meeting established and well-defined service levels at a cost that represents the highest life cycle value to the utility's ratepayers. This may lead to new capital projects or shifts in O&M activities. By adopting an asset management approach, SPU is better able to ensure cost effectiveness in service delivery in the long-run.

Elements of SPU's asset management approach were described in the *2007 Water System Plan*. One key element is development of a business case for each project (formerly known as a Project Development Plan) that includes a clearly defined problem, an analysis of alternative solutions, and a benefit-cost analysis to inform a preferred alternative decision. Business cases for projects or programs that are projected to cost \$1,000,000 or more over their life, considering both capital and O&M costs, must be reviewed by SPU's Asset Management Committee (AMC), which is composed of SPU's Executive Team. Water CIP projects that are estimated to cost less than \$1,000,000 must be reviewed by the AMC for the water line of business. Such approvals support asset management by making deliberate decisions about projects and programs in a transparent manner, fully informed by financial, environmental, and social impact life-cycle costs and benefits of the business case.

Many of the projects that are included here have not yet gone through a final business case evaluation and review by the AMC.

The project descriptions, scope, budget and timing are based on best current planning.

6.2 BUSINESS AREA ACTIONS AND COSTS

Previous chapters of this water system plan identify key actions for each water utility business area over the next 10 years. Those key actions related to capital projects are recapped below for each business area. An overview of the 2019-2028 CIP budget, summarized according to business areas, is presented in Table 6-1. The detailed CIP is provided with the Capital Facilities Plan as an appendix. CIP cost estimates presented in this plan are preliminary and subject to change as the projects are further developed and analyzed. CIP projects are subject to AMC approval and budget adoption by the Seattle City Council.

Table 6-1. Capital Improvement Program Budget 2019-2028
(2018-2023 Adopted CIP, plus 2024-2028 Estimate, in thousands of 2017 dollars)

Business Area	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Water Resources	1,966	2,253	2,816	2,825	3,575	2,584	2,974	11,752	6,117	2,124	38,986
Water Quality and Treatment	5,822	19,028	1,802	6,753	16,901	8,497	821	801	781	6,783	67,988
Transmission	12,176	10,508	11,401	3,880	4,482	4,305	13,686	16,382	17,620	16,688	111,129
Distribution	56,201	48,612	35,341	33,122	35,790	58,654	59,689	58,686	57,316	57,043	500,454
Major Watersheds	14,730	2,239	1,684	1,509	1,629	1,471	889	893	521	1,122	26,688
Other	15,664	14,262	16,002	10,298	9,878	24,144	24,263	20,238	17,555	16,655	168,957
Total	106,558	96,902	69,047	58,387	72,254	99,654	102,321	108,751	99,910	100,416	914,201

6.2.1 Water Resources

Major CIP projects for the Water Resources business area include the following:

- Implementation of the 2019-2028 Water Use Efficiency program for the Saving Water Partnership, which is budgeted at \$1.045 million per year¹.
- Continuation of the Seattle-only low-income conservation assistance program at a cost of almost \$700K per year.

¹ This is less than what was adopted in November 2018 for the 2018-2023 CIP, but reflects the program funding level for the 2019-2028 WUE Goal described in Chapter 2.

- Completion of Overflow Dike Improvements to raise the crest to elevation 1554 feet. The CIP includes \$6.1 million in 2024-2027 for this work.
- Completion of any capital improvements resulting from regular inspections by Ecology and FERC of SPU's dams and related infrastructure, as well as flood passage improvements at Landsburg Diversion Dam on the Cedar River and improvements to the Cascades Dam at Lake Youngs. The current Dam Safety program CIP totals to \$15.3 million in 2019-2028.

6.2.2 Water Quality and Treatment

Reservoir improvement projects comprises the bulk of the CIP projects in the near-term for the Water Quality and Treatment business area:

- Replacement of the floating covers at Lake Forest Park and Bitter Lake Reservoirs, which is budgeted at \$64 million in the 2019-2024 period.
- Additional budget for seismic and other upgrades at the treated water reservoirs is included beyond 2024.

The CIP also includes approximately \$4 million in 2019-2028 for various smaller scale water quality and treatment facility rehabilitation and improvement projects that relate to public health protection and drinking water regulatory compliance.

6.2.3 Transmission

The major CIP projects identified for the transmission system include the following:

- Transmission Pipeline Rehabilitation, including any additional work to mitigate the risk of pipe failure in the Tolt Slide area, is budgeted at over \$54.3 million in 2019-2028.
- Implementation of cost-effective cathodic protection for transmission pipelines, which is budgeted for a total of \$17.6 million in 2019-2028.
- Seismic improvements to transmission pipelines and facilities are included at almost \$32.1 million in 2019-2028.
- Air valve chamber replacements and system dewatering improvements are budgeted at approximately \$150K per year.

- Purveyor Meter Replacements are estimated to cost approximately \$200K per year through 2020 and \$90K thereafter.

6.2.4 Distribution

Capital improvements in the distribution system comprise almost one-half of the total CIP for 2019-2028. Several ongoing improvement programs and other major CIP projects identified for the distribution system include the following:

- Relocation, rehabilitation or replacement of water mains and appurtenances impacted by other projects, primarily transportation-related projects, but also other utility projects. The CIP includes \$128.7 million for these types of projects for 2019-2028.
- Water main rehabilitation to address aging infrastructure needs is budgeted at more than \$143 million for 2019-2028, with significant increases beginning in 2024, from less than \$4 million per year to approximately \$25 million per year.
- Water main extensions and new taps and hydrant installations to new developments comprise almost \$85 million in the 2019-2028 CIP.
- Seismic improvements to distribution mains, facilities and other infrastructure are included at approximately \$59 million in 2019-2028.
- Miscellaneous distribution system improvements and modifications, including fire flow improvements, are budgeted at approximately \$600K per year.
- Pump station improvements, in the transmission and distribution system, are budgeted at over \$5 million in the 2019-2028 CIP.
- Improvements to various storage tanks are budgeted at more than \$17 million in the 2019-2028 CIP.
- Replacement of leaking or substandard service connections, including those with lead whips, is budgeted at almost \$45 million in the 2019-2028 CIP.
- Upgrades to or replacement of hydrants, valves, chambers and meters, as well as other system modifications, are budgeted at \$12 million in the 2019-2028 CIP.

6.2.5 Major Watersheds

Projects in the Major Watersheds business area are not covered in detail in this water system plan, but include the following:

- Improvements to roads and bridges within the watersheds, which is estimated to cost almost \$1.9 million in the 2019-2028 CIP.
- Ongoing programs related to the Cedar River Watershed Habitat Conservation Plan, which are budget at \$9.5 million in the 2019-2028 CIP.
- Upgrades to or replacement of facilities associated with the Cedar River Sockeye Hatchery (including the broodstock collection weir), and the Landsburg fish ladder, which total to more than \$15 million in the 2019-2028 CIP.

6.2.6 Other Water Utility Capital Projects

In addition to the major projects discussed in this water system plan and summarized above, SPU has identified a number of other water system capital projects to be implemented over the next ten years. Projects involving more than one business area yet important for achieving the overall goals of the drinking water utility are also included here. These projects and programs comprise just over 20 percent of the CIP for 2019-2028. The costs for these projects and programs are summarized in Table 6-2.

**Table 6-2. Other Capital Projects and 10-Year CIP Costs
(2018-2023 CIP, plus 2024-2028 Estimate, in thousands of 2017 dollars)**

Capital Project or Program	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Water System Plans	48	0	0	0	0	0	0	155	522	321	1,046
In-Town Facilities	5,856	4,599	4,890	1,667	830	9,632	10,547	8,288	6,211	5,792	58,311
Regional Facilities	705	2,020	3,986	1,724	1,897	7,361	6,566	4,644	3,672	3,392	35,966
Integrated Control/Monitoring Program	343	334	326	318	310	310	310	310	310	310	3,184
Security Improvements	1,356	1,207	849	829	1,121	1,121	1,121	1,121	1,121	1,121	10,967
Heavy Equipment Purchases	1,904	1,857	1,907	1,856	1,811	1,811	1,811	1,811	1,811	1,811	18,389
1% for Arts	232	337	201	156	251	251	251	251	251	251	2,433
Technology	5,220	3,907	3,842	3,749	3,657	3,657	3,657	3,657	3,657	3,657	38,661
Total	15,664	14,262	16,002	10,298	9,878	24,144	24,263	20,238	17,555	16,655	168,957

6.3 LONG-RANGE CAPITAL FACILITIES PLAN BUDGET

In addition to developing the ten-year capital improvement program summarized above, SPU has developed its best estimate of a Capital Facilities Plan (CFP) budget through 2040, given what is known and anticipated at this time, including our understanding of future regulations. The long-range CFP represents a continuation of the programs in the 10-year CIP. Beyond 2028, the range of uncertainty in project costs and timing is greater. While projections are shown through 2040, experience has shown that new requirements emerge and projections change over time. In particular, many programs are shown with uniform expenditures in each future year even though it is likely that the costs will be concentrated into some years as specific projects are identified and scheduled. In particular, this CFP does not address any potential major emergency or disaster which could lead to the need for a new major project. SPU would most likely attempt to smooth out expenditures, but this is not always possible.

The CFP budget estimate is provided as an appendix and summarized in Table 6-3. The CFP totals to almost \$2 billion for 2019 through 2040. Almost 60 percent of the current CFP is for improvement to and rehabilitation of the distribution system.

Table 6-3. Capital Facilities Plan Budget through 2040
(2018-2023 CIP, plus 2024-2040 Estimate, in thousands of 2017 dollars)

Business Area	2019-2020	2021-2025	2026-2030	2031-2035	2036-2040	Total
Water Resources	4,219	14,774	22,121	5,170	4,975	51,259
Water Quality and Treatment	24,850	34,773	16,798	13,089	5,481	94,991
Transmission	22,683	37,755	83,674	96,330	85,721	326,162
Distribution	104,813	222,596	291,168	276,187	253,817	1,148,582
Major Watersheds	16,969	7,182	4,498	8,323	7,155	44,127
Other	29,925	84,584	76,034	54,504	50,063	295,111
Total	203,460	401,664	494,294	453,603	407,212	1,960,232

*See Appendix for additional detail.

6.4 POTENTIAL ADDITIONAL CFP BUDGET NEEDS

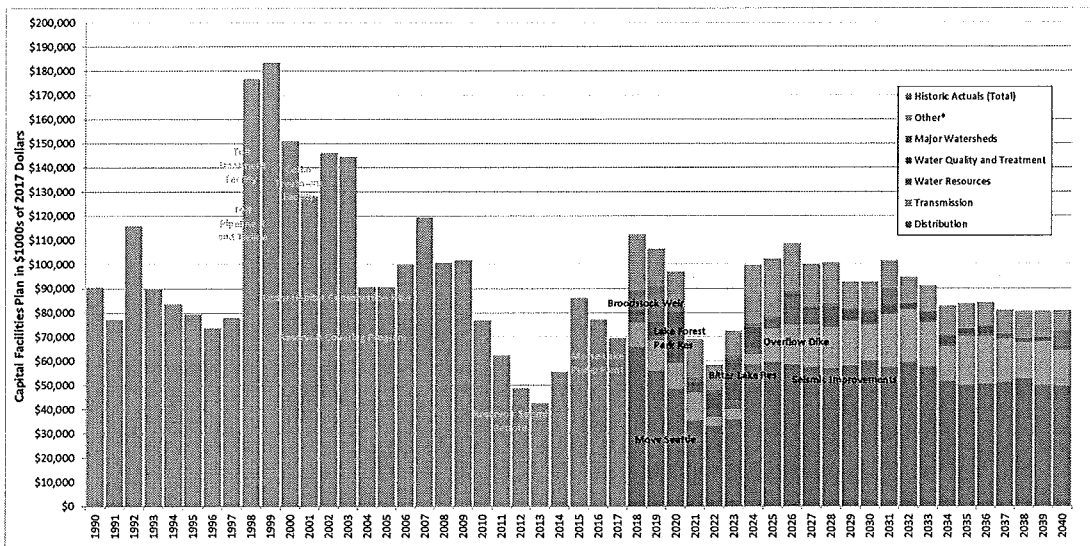
In developing the CFP, SPU identified several capital projects that could also occur but the costs and timing are less certain. It is possible, though, that SPU would reduce or defer other projects to accommodate these additional projects within current budget projections. These additional projects are:

- Extension of the regional water conservation program beyond 2028.

- Additional work in the near-term in the Dam Safety program for Tolt Dam debris boom replacement, spillway repair and dam warning system replacements and upgrades.
- Improvements to meet any requirements associated with the pending water right permits for the Seattle Well Fields.
- Capital budget to implement climate change adaptation options based on further analysis.
- Additional budget for electrical upgrades at Cedar Falls and potentially providing permanent power supply to the Morse Lake Pump Plant to improve reliability.
- Possible upgrades to the Cedar Treatment Facility should additional treatment be required or desired.
- Additional budget for the Water Main Rehabilitation program to address aging infrastructure needs.
- Potential additional land acquisitions in the Kerriston Road area.

6.5 SUMMARY

Figure 6-1 graphically represents SPU's long-range CFP budget for the water utility, including the potential additional budget needs described above. Capital spending is expected to be highest in the earlier years, and on the order of what was spent in the late 2000s, due to significant expenditures associated with the Move Seattle transportation levy (Distribution). This is followed by increased expenditures for the Broodstock Weir (Major Watersheds) and to replace the floating covers at Lake Forest Park and Bitter Lake Reservoirs (Water Quality and Treatment). Starting in 2024, capital budget estimates increase for watermain rehabilitation in the Distribution system and seismic improvements in the Transmission and Distribution systems. These capital budget needs are subject to change as project timing and costs better understood.



* Other includes Fleets, Facilities, Security, Information Technology, SCADA and other miscellaneous projects.

Figure 6-1. Historic and Proposed Capital Facilities Plan Spending through 2040

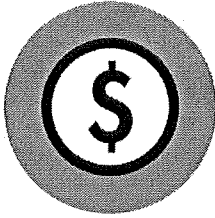
SPU's 2013 *Water System Plan* included a long-range capital facilities plan for the water utility. Table 6-4 compares the CFP budget for the 2013 plan with the CFP budget presented in Table 6-3 and Figure 6-1.

As Table 6-4 shows, SPU has increased its capital spending projections for the 2018-2040 period relative to that provided in its 2013 *Water System Plan* primarily due to increased expenditures for the transmission and distribution system, including those related to transportation projects, water main rehabilitation, additional seismic improvements, cathodic protection and transmission pipeline rehabilitation.

Table 6-4. Comparison of Capital Facilities Plan Budget Estimates from 2013 and 2019 *Water System Plans*
(in total millions of dollars for the year range shown)

Water System Plan	2018-2020	2021-2025	2026-2030	2031-2035	2036-2040
2013 (in 2017 \$s)	191	301	268	256	255
2019 (in 2017 \$s)	316	402	494	454	407
Increase	125	101	226	198	152

Assumes 2.5% inflation



CHAPTER 7

FINANCIAL PROGRAM

This chapter describes the likely methods of financing the estimated cost of operating SPU's water system and investing in the capital projects described in Chapter 6.

7.1 FINANCIAL POLICIES

Financial management of the water system is directed by formal financial policies adopted by the City Council and by informal guidelines that have evolved over time in response to specific issues. These policies and guidelines are used to decide how to finance water system operations and capital projects. They are intended to ensure that the water system finances its costs in such a manner that specific policy goals are achieved. These goals are:

- To ensure the financial integrity of the water utility.
- To moderate rate increases for water system customers over the near and medium term.
- To ensure an equitable allocation of capital costs between current and future ratepayers.

In 2005, the City Council adopted new water system financial policies that reflect changes and additions to the financial policies adopted in 1992. The new financial policies are more appropriate for the current financial environment and capital financing requirements, and also reflect changes made in 2005 to the conditions for activity in the Revenue Stabilization Subfund. The financial policies are as follows:

1. Maintenance of Capital Assets. For the benefit of both current and future ratepayers, the municipal water system intends to maintain its assets in sound working condition. Future revenue requirement analyses will include provision for maintenance and rehabilitation of facilities at a level intended to minimize total cost while continuing to provide reliable, high quality service.
2. Debt Service Coverage. Debt service coverage on first-lien debt should be at least 1.7 times debt service cost in each year on a planning basis.
3. Net Income. Net income should generally be positive.

4. Cash Funding of the Capital Improvement Program. Current revenues should be used to finance no less than 15 percent of the municipal water system's adopted CIP in any year, and not less than 20 percent of the CIP over the period of each rate proposal. Cash in excess of working capital requirements may be used to help fund the CIP.
5. Eligibility for Debt Financing. Unless otherwise authorized by the City Council, the following criteria must be met before project expenditures are eligible for debt financing:
 - Project is included in the CIP.
 - Total project cost exceeds \$50,000.
 - Project has expected useful life of more than two years (more than five years for information technology projects).
 - Resulting asset will be owned or controlled by SPU, is part of the regional utility infrastructure, or represents a long-term investment for water conservation.
 - Consistent with generally accepted accounting practices, project costs include those indirect costs, such as administrative overhead and program management, that can be reasonably attributed to the individual CIP project.

Revenue Stabilization Subfund is available to offset shortfalls in metered water sales revenues or to meet financial policies.

6. Revenue Stabilization Subfund. A target balance of \$9 million will be maintained in the Revenue Stabilization Subfund, except when withdrawals resulting in balances below this amount are needed to offset shortfalls in metered water sales revenues or to meet financial policy requirements. Funds in excess of the minimum balance may be used to meet operating expenses, pay CIP expenditures, or meet financial policy requirements.

SPU, when all financial policy targets are exceeded, is required to deposit water sales revenue above planned revenue. SPU may also make discretionary deposits to the Revenue Stabilization Subfund, provided that these discretionary deposits are in excess of the amounts required to meet the financial policy requirements. Should the balance in the Subfund fall below the target balance, SPU must submit within one year a water rate proposal that rebuilds the balance in the Subfund.

7. Cash Target. The target for the year-end operating fund cash balance is one-twelfth of the current year's operating expenditures.

8. Variable Rate Debt. Variable rate debt should not exceed 15 percent of total outstanding debt. Annual principal payments shall be made on variable rate debt in a manner consistent with fixed rate debt.

The financial policies help determine how much revenue the utility must collect from its customers each year to meet the cost of operations, maintenance and repair, and capital improvements. Because of this, rate impacts stemming from specific courses of action recommended in this water system plan cannot be determined without also considering what financial policies are to be followed. If an action's rate impacts are unacceptable, the action can be scaled back to reduce costs or alternative financial approaches can be considered to spread costs over a longer period.

7.2 FINANCIAL HEALTH

Financially healthy organizations have the flexibility to respond to unexpected circumstances. Such circumstances may include new, unexpected-but-essential tasks or a shortfall in earnings. Flexibility can mean redirecting expenditures, borrowing money to meet an unexpected need, or other approaches.

The use of debt to finance a significant amount of new and replacement infrastructure has kept rates low but increased the amount of revenue used to repay loans.

In the past, the water system financed a significant amount of new and replacement infrastructure through the use of debt. While it helped keep rates low at that time, it has also greatly increased the portion of revenue that is used to pay off the debt. In 1990, 20 cents of every revenue dollar were used to repay loans. In 2016, 33 cents of every revenue dollar were used to repay loans. This means that SPU has less flexibility in how it spends its revenues. Current revenues that are used for new facilities are the most flexible resource for meeting unexpected needs.

The increasing commitment of each revenue dollar to pay off debt makes sources of financial instability riskier because SPU has less flexibility to adjust to revenue shortfalls and unanticipated needs. One cause of revenue fluctuation for SPU is seasonal rates, which are used to discourage water use in the summer when water is most scarce. Variations in summer weather can cause annual water use to vary from an average year by as much as 5 percent. Since this variation happens in the summer, when rates are higher than the winter, summer weather variation can result in annual water sale revenue shortfalls of up to 8 percent. The Revenue Stabilization Subfund can be used to offset revenue shortfalls beyond these levels.

Reducing this weather-related revenue risk could also be accomplished by reducing the difference between winter and summer rates. Higher winter rates or increasing the base service charge would provide more annual revenue and therefore more of a “cushion” against revenue shortfalls. However, changing the seasonal rate structure would reduce incentives to conserve water in the summertime.

There are two key indicators used by the financial community that provide a measure of how well SPU is doing in the areas identified above. The first, debt-service coverage, is an annual measure of the revenue an organization has available to repay debt, divided by debt payments. Debt-service coverage is calculated after operational expenses and some taxes have been paid. While the legal requirement in bond covenants is 1.25, SPU’s debt-service coverage policy target is 1.70. The higher target provides SPU flexibility when actual revenues are lower than projected. This flexibility enabled SPU to collect the necessary revenue to stay above the legal requirements, but below the policy target, when demand in the late 2000’s and early 2010’s was lower than originally projected and variable rate debt was refunded into fixed rate debt when market conditions changed. Since 2013, debt service coverage has not been lower than 1.77, well above the policy target.

SPU’s water utility is rated Aa1 by Moody’s and AA+ by Standard and Poors.

The second key indicator is the debt-to-assets ratio. The debt-to-assets ratio is the outstanding debt of the utility divided by the sum total of its assets. The debt-to-assets ratio shows how reliant the utility is on debt to finance its infrastructure and how much flexibility it has to respond to unexpected circumstances. SPU’s debt-to-assets ratio for the water system is currently higher than comparable utilities and is at a level that could be a concern to the financial community, which could result in higher debt financing costs if investors view SPU as overextended. To counteract this concern, SPU has generally decreased the levels of debt financing and has forecasted continuation of this trend in the near future. As a result, in recent years, SPU has had excellent bond ratings.

While SPU has been generally decreasing the levels of debt financing of the capital improvement program, exceptions occurred in 2008 and 2009 when revenues fell to the point where cash available to fund the capital program was less than 20 percent of total spending, forcing more reliance on debt. Revenue financing of capital projects is expected to remain above 35 percent through 2023, decreasing to around 21 percent from 2024 through 2040. In the near term, the binding financial policy target remains debt service coverage. In order to meet debt service coverage targets,

revenue requirements will generate more cash than needed to cover operating expenses and other financial policy targets. The excess cash will be put towards the capital program. By investing more current revenue in infrastructure, SPU will reduce its reliance on debt and thereby reduce its debt-to-assets ratio. The necessity of meeting the debt service coverage targets will drive rate increases in the coming years. Beginning in 2024, the binding financial policy is expected to move back and forth between debt service coverage and cash financing of the capital program.

A summary of SPU's financial results for its water utility over the past six years is shown in Table 7-1.

Table 7-1. Financial Revenues and Expenditures, 2011-2016
(in millions of dollars)

	2011	2012	2013	2014	2015	2016
Revenues						
Water Sales	183	199	217	225	232	233
Other (tap fees, interest income, operational grants, reimbursements, etc.)	19	25	27	26	38	34
Total	202	224	244	251	271	266
Expenditures						
Operations and Maintenance	78	81	89	93	101	103
Taxes	31	34	38	40	42	42
Debt Service	80	78	79	78	79	83
Revenue-Financed Construction	16	26	24	35	53	45
Total	204	219	230	246	275	273
Net of Revenues and Expenditures	(1)	5	15	6	(4)	(6)

7.3 FUNDING SOURCES

The primary source of funding for SPU's water utility is revenues derived from the wholesale and retail sales of treated drinking water.

The primary source of funding for SPU's water utility is revenue derived from wholesale and retail sales of treated drinking water. To finance capital facilities, SPU relies primarily on borrowing. SPU also receives contributions from developers, but that funding source plays a much smaller role in capital financing. The water system has entered a new period of capital expenditures, moving away from large, centralized projects to smaller, decentralized infrastructure improvements.

As stated earlier, debt service coverage is the binding financial policy through 2024, when debt service coverage and cash financing of CIP alternate as the binding policy. In years where debt service is the binding constraint, revenues will be in excess of operating expenses, leaving excess cash to fund the CIP. As a result, from 2018 through 2040, SPU plans to meet or exceed its

financial policy of financing 20 percent of its capital facilities plan with revenues. However, because of the large size of the CIP in the next six years, SPU will still rely heavily on borrowing.

7.3.1 Water Rates

In 2016, water sales made up 93 percent of operating revenues. Rates must provide sufficient revenue to operate the water system. Rate-design objectives include:

- Provide financial soundness.
- Advance economic efficiency.
- Promote customer equity.
- Encourage customer conservation.
- Contribute to transparency and customer understanding.
- Reduce impacts on low-income customers.

The affordability of rates to retail customers is also an issue considered by City Council during rate setting.

In most years, City Council has set rates for 3-year periods. Rates were last set in 2017 for 2018-2020. These rate schedules are provided in the appendices.

Rates are set by customer class. The major customer groupings are wholesale and retail. Wholesale rates are set as described in their contracts with SPU. Retail customers are further categorized into residential and general service classes (multi-family housing is considered general service for rate-setting purposes). The rate structure for each of the customer classes includes a fixed monthly charge, which is graduated by the size of the service, and a seasonally-differentiated commodity charge. The combination of fixed and commodity charges can be fine-tuned to meet the rate objectives identified above. For example, the fixed charge can be set to recover costs that are unrelated to the amount of water used, such as billing and meter reading. Similarly, seasonal commodity rates can be set to reflect the cost differentials that exist between winter, when streamflows are high and demand is low, and summer, when streamflows are low and demand is high. Setting rates so that the bills of individual customers reflect the cost of serving them is especially important in achieving customer equity because the most commonly used definition of equity is that bills reflect costs.

To encourage conservation in the summer period, the residential commodity rate is structured with three tiers. The first tier, up to

If we use less water, shouldn't it cost less?

Most of the utility's costs are the same whether we sell a lot of water or a little. These fixed costs include debt service (principal and interest paid for past capital projects) and the labor needed to operate the system, treat the water, and respond to problems 24 / 7.

When we sell less water, we need to charge more per gallon to be sure that SPU makes enough revenue to operate and maintain the water system while meeting financial policies set by the City Council.

five hundred cubic feet (CCF), is designed as a “lifeline” to meet basic needs. The second tier, from 5 to 18 CCF, is billed at a higher rate than the first. The third tier¹, above 18 CCF, is set at an even higher rate to discourage the use of very large volumes of water, often for irrigation.

System-wide average rates² are likely to increase faster than the rate of inflation, particularly in the near-term. A significant portion of current and near-term rates are due to debt service on prior capital investments, such as the Tolt and Cedar Water Treatment Facilities. Going forward, those effects are still felt as future CIP and O&M spending will put pressure on debt service coverage requirements, thereby requiring increasing rates. Additionally, future rate levels depend on revenue requirements as well as the amount of water sold. With demand for water forecasted to generally decline through 2040, there will be no growth in water sales to absorb any increases in revenue requirements.

While the above discussion applies to the system as a whole, there is a categorical difference between the rates paid by wholesale customers and the rates paid by retail service customers.

Wholesale customers do not pay for SPU’s distribution system, since they are not served by these facilities. They pay only for their share of water supply, treatment, and transmission. Going forward, the CIP contains fewer regional projects in the areas of supply, treatment, and transmission. The rates charged by SPU’s wholesale customers to *their* customers include the cost of the wholesale customer distribution systems, and would be different than what SPU charges its retail customers.

7.3.2 Debt Financing

From 2018 through 2040, 76 percent of the Capital Facilities Plan (CFP) is expected to be financed with debt, as shown in Figure 7-1, below. Debt is expected to be used to finance 64 percent of CIP through 2023 and 79 percent thereafter. Until 2024, debt service coverage is expected to significantly alter the way capital projects are financed. Because of the large debt incurred since 1999, a larger portion of revenue must go to finance capital facilities to meet bond covenant requirements and financial policy targets. To

¹ The third tier was instituted in 2001 in response to Ordinance 120532, the Initiative 63 Settlement Ordinance.

² System-wide average rates are defined as the average rate paid by all customers of the utility. It is computed by taking the total water sales revenue divided by total system water use by all customers.

maintain debt service coverage requirements, revenue is higher than otherwise would be required. The additional revenue will then be utilized to fund the current capital program, reducing debt issuance and future debt service requirements.

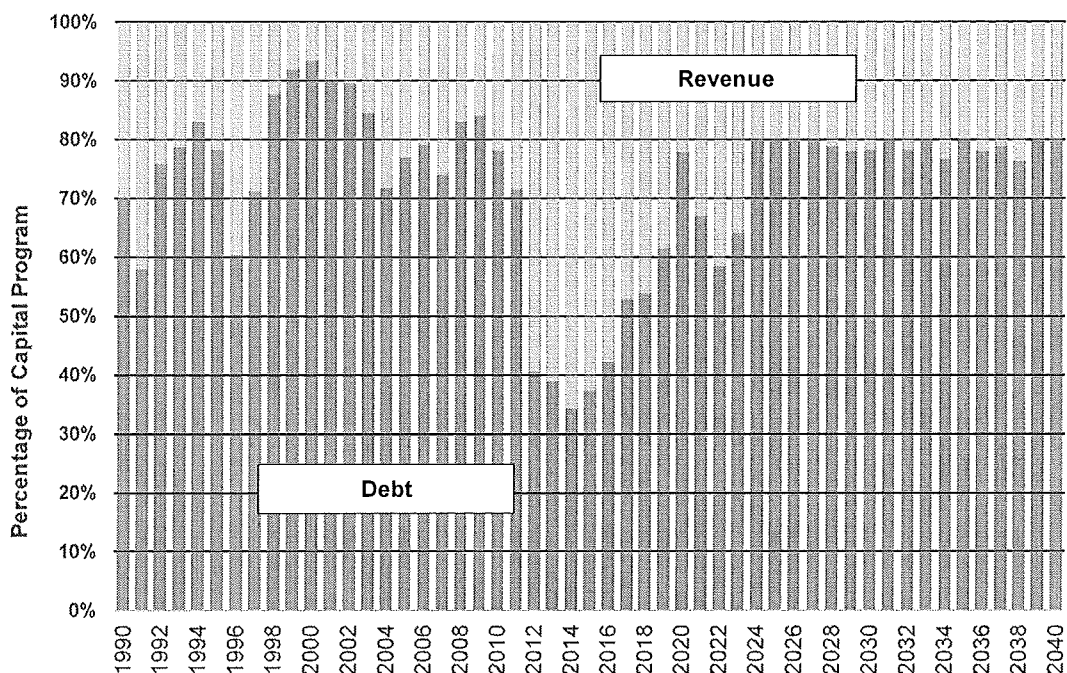


Figure 7-1. Past and Planned Debt Financing

7.3.3 Debt-to-Assets Ratio

From the mid-1990's through 2010, SPU borrowed extensively in order to finance the capital program and the building of new assets. This level of borrowing increased the debt-to-asset ratio 40 percent over 15 years, peaking at 75 percent in 2011, as shown in Figure 7-2. Beginning in 2012, SPU has taken advantage of strong bond ratings and favorable interest rates to refinance large portions of historical debt. In three separate re-financings, SPU lowered outstanding debt by \$50 million while also lowering debt service payments. These refinancing results, combined with low capital expenditure in the early 2010's, dramatically lowered the debt-to-asset ratio. Increased revenue financing is expected to continue lowering the debt-to-asset ratio through the mid-2030's.

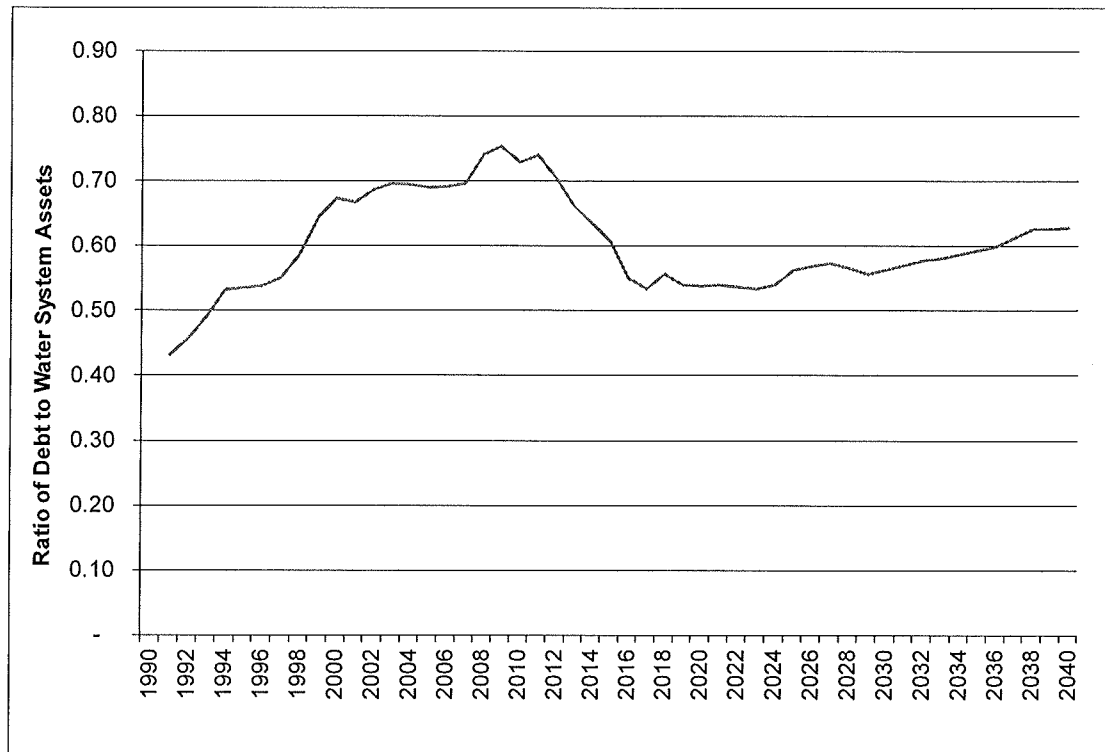


Figure 7-2. Past and Projected Debt-to-Assets Ratio

7.3.4 Alternative Financing Paths

A lower debt-to-assets ratio could be achieved more quickly by higher rate increases in the near-term, coupled with deferral of part of the capital program. This would allow a greater portion of the capital program to be financed out of revenues over time. However, it would also result in higher near-term rates, and deferring projects could prevent the water system from complying with regulatory agreements made with state and federal agencies. The current approach strikes a balance between short-term debt service needs and long-term financing that will provide the utility stability and address important capital needs and operating requirements.

7.4 FINANCIAL MODEL CASH FLOW ANALYSIS

The capital improvements summarized in the Part II, Chapter 1, together with projected operating expenses through 2040, were incorporated into the water system's financial model in order to develop a long-term picture of rate requirements and financial performance. The anticipated cash flows and financial performance generated by the financial model are summarized at five-year intervals in Table 7-2. The debt service coverage of 1.7

controls rates through 2032. After 2032, SPU's financial policy target for cash-to-CIP becomes binding for rates.

Table 7-2. Summary of Water System Cash (in millions of dollars)¹

Revenue/Expenditures ¹	2020	2025	2030	2035	2040
Revenues					
Water Sales	263	312	377	438	549
Other (tap fees, interest income, operational grants, reimbursements, etc.)	30	35	40	44	51
Total Revenues	293	347	416	482	601
Expenditures					
Operations and Maintenance	131	160	195	238	289
Taxes	46	58	73	86	110
Debt Service	90	103	121	131	163
Revenue-Financed Construction	16	17	19	17	18
Total Expenditures	283	339	408	471	580
Net Revenue	10	8	8	11	20
Debt Service Coverage	1.7	1.7	1.7	1.7	1.8
Debt-to-Assets Ratio	54.23%	57.84%	55.63%	60.45%	62.13%
Cash Balance	33	38	43	48	53
Capital Improvement Program					
	2018-2020	2021-2025	2026-2030	2031-2035	2036-2040
Revenue Financing	99	96	96	96	95
Contributions in Aid of Construction	20	36	40	45	51
Debt Financing	212	338	512	531	538
Total CIP Financing	332	469	648	672	684

¹Notes and Assumptions:

- Actual dollars spent or received in any given year; revenues and expenditures are inflated to off-set the erosion of purchasing power over time due to inflation.
- Revenues and expenditures do not net zero in this summary because of rounding errors, contributions to cash balances, and lags between when revenues are billed and when they are received.
- Operations and Maintenance assumed to increase by 40 percent from 2018 through 2040 in real terms, or 1.5% compounded annual growth per year. For comparison, from 1990 to 2017, O&M costs have grown at an annual rate of 1.3% in real terms.
- The forecast assumes bond issues every other year at 5.5% interest and 30-year terms.
- The forecast assumes inflation of 2.5% per year.

Cash expenditure remains high throughout the plan. From 2018-2025, cash expenditure is high because capital expense is largely financed by revenue. The largest capital programs include Distribution System Improvements, Transmission Pipeline Upgrades, Water Main Rehabilitation and projects related to transportation improvements. From 2026-2040, revenue expenditure remains level as capital expenditure remains fairly consistent and financial policy dictates minimum spending levels. After 2025, operations and maintenance spending growth is the primary driver of increased spending.

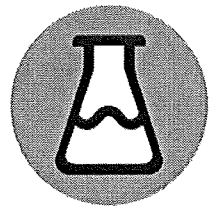
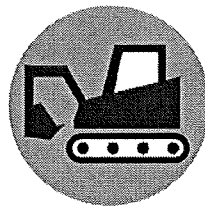
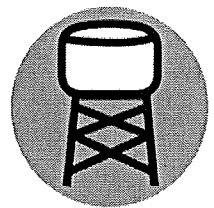
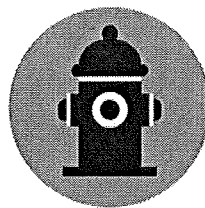
7.5 CONCLUSION

SPU has been making, and continues to make, significant investments to protect public health, comply with federal and state regulations, and replace aging infrastructure. While SPU has invested in major regional facilities in the past decades, the need is now shifting to significant capital investments to rehabilitate and improve the distribution system and to improve performance after an earthquake. Implementation of this water system plan will help to ensure that SPU meets its mission to provide efficient and forward-looking utility services that keep Seattle the best place to live and work for everyone.



**Seattle
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2019 WATER SYSTEM PLAN

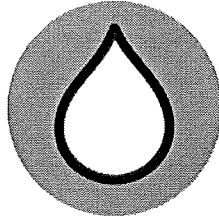


Our Water. Our Future.

APPENDICES

Volume 2
July 2018

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

APPENDIX A

WATER RESOURCES

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-1
Official Yield Estimate and Long-Range Water Demand Forecast

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Seattle Public Utilities Official Yield Estimate and Long-Range Water Demand Forecast

Inputs and Assumptions for the Firm Yield Estimate

Firm yield of the water supply system is estimated using a simulation model developed by Seattle Public Utilities called the Conjunctive Use Evaluation (CUE) model. Additional details of the model and inputs are documented in the preliminary draft report titled *Firm Yield of Seattle's Existing Water Supply Sources*, December 1, 2016, prepared by Seattle Public Utilities (SPU).

Model Inputs and Assumptions

- ⇒ Firm yield is based on the **98% reliability standard**—two shortfalls occur in the 87.5 years of historic record.
- ⇒ **Historic weekly inflows** reconstructed for water year 1929 through part of 2016 (October 1, 1928 through March 30, 2016) are used.
- ⇒ **Total system demand** is shaped on a monthly demand pattern based on the average of actual deliveries from calendar year 2006 through 2014.
- ⇒ **Sources of supply are operated conjunctively as a single system.**
- ⇒ **Operational assumptions include:**
 - Cedar River System:
Meet Cedar River Habitat Conservation Plan instream flow commitments below Landsburg, assuming flashboards in place on Overflow Dike.
Fixed rule curve for Cedar Reservoir of 1550' for October-December and 1563' for March-August.
Minimum levels for Chester Morse Lake: 1532'; Masonry Pool: 1510'
Meet diversion limits specified by the 2006 Agreement with the Muckleshoot Indian Tribe.
 - South Fork Tolt System:
Meet instream flows from 1988 Tolt Settlement Agreement (with treatment project).
Fixed rule curve 1754' for October-January; 1765' for March-August.
Minimum level for South Fork Tolt Reservoir: 1710'
Treatment/Transmission capacity: 120 MGD
 - Seattle Well Fields:
10 MGD withdrawn for 14 weeks as needed from July-December.
5 MGD recharged for 14 weeks from January-March.

Results

Based on the above, the **system-wide firm yield is 172 million gallons per day.**

Inputs and Assumptions for the Water Demand Forecast Model

SPU is using the same basic water demand forecast model that was developed and for the 2007 and 2013 Water System Plans. Following a 2006 literature review of demand forecast models used by other utilities, SPU settled on a "Variable Flow Factor" approach. As with simpler fixed flow factor models, current water demand flow factors are calculated by sector (single and multi-family residential, non-residential) for Seattle and each individual wholesale customer. However, like an econometric model, the Variable Flow Factor model reflects the impacts of variables such as price, income, and conservation on water flow factors for each sector over time. This approach takes advantage of past econometric analysis to provide estimates of how some of the variables (price and income) affect demand. SPU's Code, Standards & Market Transformation ("code" for short) Savings model, as well as estimates of programmatic conservation savings, are then used to estimate the impacts of code and programmatic conservation on the flow factors over time. The structure of the demand forecast model is summarized in the flow chart on the next page while the model inputs and assumptions are outlined, below.

The structure of the water demand forecast model is represented in the flow chart on the following page. Intermediate steps and final results are shown as rectangles. Model inputs are shown as ovals with the gray shaded ovals indicating which inputs are subject to uncertainty and modeled using Monte Carlo simulations.

Model, Inputs and Assumptions

⇒ **Weather adjusted base year consumption:**

By sector

- single family residential
- multifamily residential
- manufacturing non-residential
- non-manufacturing non-residential

By service area

- Seattle retail service area
- Individual wholesale customers

Base Year

- 2016

Weather

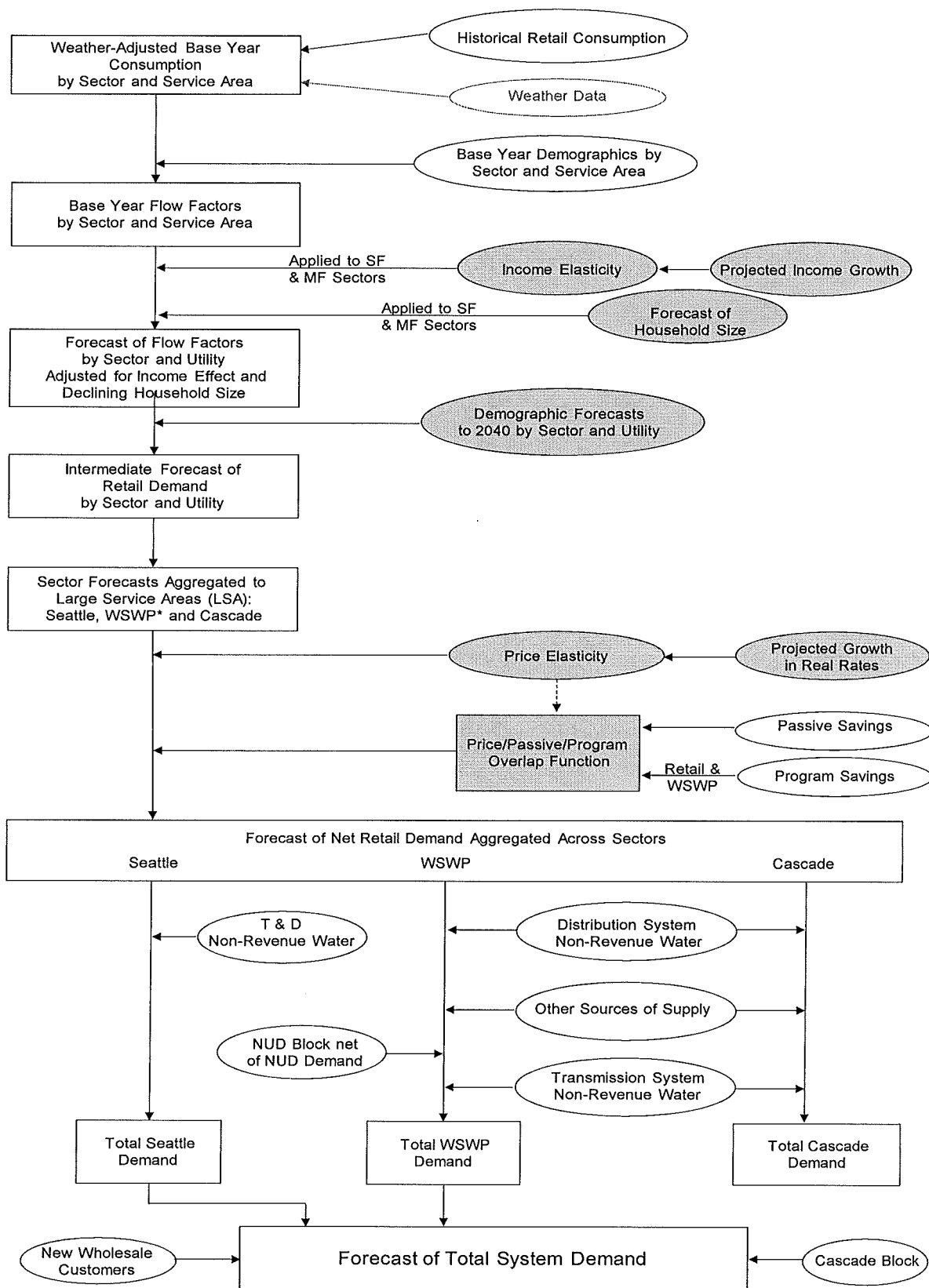
- Sea-Tac Airport monthly average daily temperature and total precipitation

Sources: SPU billing data, Annual Purveyor Surveys, NOAA

- ⇒ **Demographics: Current and projected single- and multi-family households and employment:** The model uses the Puget Sound Regional Council (PSRC) Land Use Baseline census-tract-level forecasts of population, households and employment to 2040 apportioned¹ to Seattle retail and individual wholesale service areas. (The forecast was published in 2014 and is the most recent version available. An update is expected in 2018.) A straight-line extrapolation of average annual growth between 2030 and 2040 is used to forecast beyond 2040. The base year for the water demand forecast is 2016. Several sources of information were used to estimate base year demographics. A first approximation was obtained by interpolating between the 2010 actuals and the 2020 forecasts in the PSRC forecast. This was compared to actual meter counts from SPU and wholesale customers for single family households as well as annual estimates of population

¹ The Land Use Baseline Forecast uses a parcel-based UrbanSim model. This made it possible for PSRC to calculate what percent of each census tract is within each utility's service area based on boundaries provided by SPU. These percents were then used to apportion the demographic forecasts to each utility.

WATER DEMAND FORECAST MODEL STRUCTURE



* WSWP = Wholesale members of the Saving Water Partnership

and households by census tract by the Washington State Office of Financial Management (OFM). Where there were significant discrepancies between the interpolated base-year forecasts of population and households and the estimates of 2016 actuals, adjustments were made to the base and early year demographic forecasts.

In the first table below is displayed PSRC's forecast of population, households, and employment in King County. The tables that follow contain these forecasts as they have been apportioned into water service areas. Separate tables are provided for all of King County, SPU's retail service area, and the service area of Full and Partial Contracts (F&P) wholesale customers.

Actual² & PSRC Forecasts of Population, Households, & Employment

King County

	Population	Households			Employment
		Single Family	Multifamily	Total	
2000	1,737,379	453,567	257,479	711,046	1,151,214
2010	1,931,249	497,853	291,379	789,232	1,181,537
2016	2,105,100	525,028	334,476	859,504	1,375,054
2020	2,169,389	539,741	357,808	897,549	1,467,620
2030	2,341,532	570,233	394,806	965,039	1,627,059
2040	2,527,589	600,611	470,624	1,071,235	1,897,261
2016-2040					
Growth	422,489	75,583	136,148	211,731	522,207
% Change	20%	14%	41%	25%	38%
Annual Rate	0.8%	0.6%	1.4%	0.9%	1.4%

As Apportioned to SPU's Retail Service Area and Full and Partial Contracts Wholesale Service Area³

	Population	Household			Employment
		Single Family	Multifamily	Total	
2000	1,012,625	260,529	173,859	434,388	750,861
2010	1,102,573	276,583	195,016	471,600	692,438
2016	1,189,546	288,315	219,172	507,487	801,406
2020	1,238,165	297,247	236,386	533,633	853,529
2030	1,317,522	307,628	257,721	565,349	938,206
2040	1,406,213	316,681	301,942	618,622	1,061,993
2016-2040					
Growth	216,668	28,366	82,770	111,136	260,587
% Change	18%	10%	38%	22%	33%
Annual Rate	0.7%	0.4%	1.3%	0.8%	1.2%

² Census data used for 2000 and 2010 population and households. 2010 employment is based on latest (2014) PSRC estimate of 2010 employment.

³ This excludes the service areas of Northshore Utility District and Cascade Water Alliance members.

As Apportioned to SPU's Retail Service Area⁴

	Population	Household			Employment
		Single Family	Multifamily	Total	
2000	617,104	151,741	128,450	280,191	569,311
2010	662,635	159,146	145,669	304,815	509,171
2016	743,796	162,005	162,839	324,844	592,115
2020	750,000	165,396	175,396	340,791	626,889
2030	777,374	166,322	190,618	356,941	686,909
2040	817,906	168,293	214,991	383,284	762,232
2016-2040					
Growth	74,110	6,288	52,152	58,440	170,117
% Change	10%	4%	32%	18%	29%
Annual Rate	0.4%	0.2%	1.2%	0.7%	1.1%

As Apportioned to the Full and Partial Contracts Wholesale Service Area⁵

	Population	Household			Employment
		Single Family	Multifamily	Total	
2000	395,521	108,788	45,409	154,197	181,550
2010	439,938	117,437	49,348	166,785	183,267
2016	474,492	126,310	56,333	182,643	209,290
2020	496,911	131,851	60,990	192,842	226,640
2030	540,148	141,306	67,103	208,408	251,297
2040	588,308	148,387	86,951	235,338	299,761
2016-2040					
Growth	113,816	22,077	30,618	52,695	90,470
% Change	24%	17%	54%	29%	43%
Annual Rate	0.9%	0.7%	1.8%	1.1%	1.5%

In the 2013 Water System Plan forecast, household size was calculated for single and multifamily households in Seattle and for wholesale customers over the forecast period based on PSRC projections of single and multifamily households and population. Since the number of households was projected to grow faster than population through 2040, household size was projected to decrease significantly. Per household flow factors were then reduced each year by the percent change in household size times the elasticity of demand with respect to household size. This elasticity was estimated to be 0.38 based on data from an end-use study conducted by the Seattle Water Department in the mid-1990s. The same methodology is used in the current forecast though it has much less impact because PSRC's most recent demographic forecast has population and households growing at the same rate so there's very little change in household size over time.

- ⇒ **Base Year Flow Factors:** Base year flow factors are obtained by dividing the weather-adjusted base year consumption for each sector (e.g. single family residential) and service

⁴ SPU's retail service area includes the City of Seattle and portions of the cities of Shoreline, Lake Forest Park and Burien, as well as portions of unincorporated King County south of the City of Seattle.

⁵ For the two wholesale customers with block contracts, Cascade Water Alliance and Northshore Utility District, the total number of households is forecast to increase by 30% and 34%, respectively, from 2016 to 2040. Over the same period, employment is forecast to grow 54% within Cascade and 48% in Northshore.

area (e.g. Bothell) by the corresponding number of households or employees in the base year.

- ⇒ **Elasticity of residential demand to changes in real (inflation adjusted) household income:** Household income is generally expected to have a positive effect on water demand. A review of the literature revealed a range of estimated income elasticities. An elasticity value of **0.27**, representing the middle of this range, was chosen. (This means that a 10% increase in household income would be expected to cause a 2.7% rise in residential demand.)

Source: Results of 2006 literature review.

- ⇒ **Forecast of annual growth in real median household income:** Beginning with the 2013 WSP demand forecast, the model has used *median* rather than *average* household income. The past 40 years has seen a widening gap between growth in average and median income. Both national and local time series on *real* per capita personal income (i.e., *average* per capita income) show rates of growth averaging about 2.0% per year. However, *median* household income in Washington State and King County adjusted for inflation has been essentially flat since reporting began in 1989.⁶ There is additional evidence that this is not just true for the median household but for most households except those at the very top of the income distribution. Analysis by economists Saez and Piketty based on 90 years of IRS data reveals that *average* household income for the bottom 90% of households has had zero real growth since 1970. Over the same 4 decades, the top 10%, 1%, 0.1%, and 0.01% of households has seen their real incomes increase twofold, threefold, fivefold and eightfold, respectively. If that trend continues with all income growth going to the top 10%, median income – and the income of all but the top 10% of households – will remain flat in real terms. More optimistic scenarios would have this pattern of increasing income inequality (1) slowing down, (2) stopping, or (3) even reversing. Those conditions would correspond to rates of median income growth (1) greater than zero but less than the growth rate in average income, (2) equal to the average growth rate, or (3) greater than the average growth rate. For the demand forecast, it is assumed that household income will grow at **0.9%** per year based on the median or about half the historical growth rate in per capita personal income based on averages.

Sources: U.S. Bureau of Economic Analysis, U.S. Census Bureau, Washington State Office of Financial Management, Dick Conway & Associates, Emmanuel Saez of UC-Berkeley.

- ⇒ **Elasticity of demand to changes in real water rates (prices):** A considerable body of literature has developed concerning the effect of price upon water demand and the inverse relationship predicted by economic theory is now well established. However, a number of complications summarized in the literature review (complex rate structures, conservation impacts, etc.) have made it difficult to estimate price elasticity with much confidence. As a result, there is a wide range of estimates in the literature but as with the income elasticity, values towards the middle of the range have been chosen for this model. These are shown below. (The value of -0.20 for single family households means that given a 10% increase in water prices, demand would be expected to decline by 2%.)

⁶ Note that real median household income hit a low in 2011 and has been growing since then. In 2015, it finally surpassed what it was in 1989.

	Single Family	Multifamily	Non-Residential
Price Elasticity	-0.20	-0.10	-0.225

Sources: Results of 2006 literature review, Seattle's 1992 econometric model.

⇒ **Forecast of annual growth in real water rates (prices):** Seattle and its wholesale customers have different water rates and different rate structures. Most customers face different marginal rates depending on whether they're residential or non-residential, what consumption block they fall in and what season it is. There is no single price of water. However, the model abstracts from all these complexities by using the average price of water, i.e., revenue requirements divided by billed consumption.

The model takes into account the increases in water and sewer⁷ rates already adopted through 2017 and the Strategic Business Plan rate path through 2023 as projected by the SPU Rates Unit in September 2017. After 2023, it is assumed that inflation-adjusted retail water/sewer rates and wholesale customer water rates will average about 0.6% per year.

Historical and Projected Annual Growth in Average Water Rates

	Seattle Retail*	Wholesale Customers*
1974-1995	2.9%	NA
1995-2016	4.0%	1.8%
2016-2023	2.1%	1.6%
2024+	0.6%	0.6%

* Seattle Retail reflects historical and anticipated increases in water and sewer rates. Wholesale is water rates only.

Sources: Historical rate and consumption data; Paul Hanna, SPU Rates 09/08/17.

⇒ **Conservation - Reductions in Water Use due to Code, Standards and Market Transformation (code):** Some conservation savings occur each year without SPU intervention due to federal and state plumbing codes setting efficiency standards for showerheads, toilets, aerators, and clothes washers. As old fixtures and appliances are replaced with new ones in existing buildings and new fixtures and appliances are installed in new construction, water use efficiency improves and conservation savings accrue. In addition, fixtures and appliances available from the market at competitive prices often become increasingly more efficient than is required by codes, especially as more years have passed since the codes were updated. "Market transformation" refers to this phenomenon along with savings from standards adopted by manufacturers. The same model developed for the 2013 WSP forecast was used to estimate these savings through 2060.

The model takes account of federal fixture and appliance codes adopted in 1992, 2002, 2007, 2012 and 2015.⁸ The model also reflects the current proportion of fixtures and

⁷ Because sewer bills in Seattle are based on metered water consumption, both water and sewer rates are assumed to impact water demand in the model. This is only the case for the retail service area, however. Many different cities and sewer districts provide sewer service in Seattle's wholesale water service area, each with different sewer rates and rate structures. Unlike Seattle's sewer rates that are entirely volume based, most other sewer providers have large fixed charges with much less of their revenue generated by volume rates. For that reason, as well as lack of information on past, current and anticipated sewer rates in the wholesale service area, the demand model for wholesale customers does not include sewer rates.

⁸ The US Department of Energy adopted a two-phase residential clothes washer efficiency standard, with the first phase effective March 7, 2015, and the second, more stringent phase, effective for January 1, 2018.

appliances sold in the market that meet the more stringent Energy Star, Water Sense, and Consortium for Energy Efficiency (CEE) standards, as well as how those proportions are expected to continue shifting in the direction of higher efficiency over time. The model assumes that aerators, showerheads, clothes washers and toilets are, on average, replaced every 5, 10, 12 and 30 years, respectively.

Projected Savings from Code, Standards & Market Transformation in MGD

	Single Family	Multi- family	Non- Residential	Total
2020	1.2	0.8	0.2	2.2
2030	4.1	3.1	0.8	8.0
2040	5.9	4.8	1.4	12.0
2050	6.7	6.0	1.7	14.5
2060	7.1	6.8	2.1	15.9

Sources: Water Research Foundation, "Residential End Uses of Water," April 2016; U.S. EPA Office of Water; Alliance for Water Efficiency; Al Dietemann (personal communication)

- ⇒ **Conservation - Reductions in Water Use due to Programmatic Savings:** Based on an analysis of CIP spending and savings achieved during the 2012-2016 period, the Water Conservation office estimates savings from hardware (CIP) programs of **0.1 mgd** per year from 2017 through 2028. There are assumed to be no additional CIP program savings after 2028. These conservation savings only apply to Seattle and other members of the Saving Water Partnership. As is explained below, the Cascade Water Alliance has a block contract with SPU which limits its demand from the Seattle system. While Cascade is expected to pursue its own conservation programs, that doesn't affect the forecast of its demand from SPU which is assumed not to exceed the block.
- ⇒ **Price/Code & Standards/Programmatic Conservation Overlap:** In past forecasts, total conservation savings were adjusted downwards to account for the overlap between different types of conservation.⁹ However in this iteration of the forecast, the "overlap function," which had resulted in an approximate 14% reduction in the estimate of total conservation savings, was turned off in order to offset the lack of estimates for several other types of conservation. The model does not include estimates of behavioral conservation savings from SPU public messaging and educational programs, or from outside sources of information and encouragement for the public to adopt water efficiency measures and develop a stronger conservation ethic. Neither has there been an attempt to explicitly capture the potential future impacts on water use of new technologies, green buildings, and decentralized systems. As a rough approximation, these other sources of conservation are taken into account by eliminating the overlap calculation.
- ⇒ **Non-Revenue Water:** Combined transmission and Seattle distribution system non-revenue water is assumed to start at 7 mgd in 2015 and increase uniformly to 9 mgd by 2060. This increase is expected to be caused by a growing number of leaks that will probably occur as the distribution system ages.
- ⇒ **Wholesale Customer Demands:**
 - Wholesale customer distribution system non-revenue water is assumed to be a constant 6% of retail water demand in the wholesale service area over the forecast period. This is added to the forecast of wholesale customers' retail demand.

Source: Annual Surveys of Wholesale Customers, 1994-2016.

⁹ The "overlap function" assumed that half of the price effect overlapped with code and programmatic savings as long as the total amount of overlap represented less than half of total code and programmatic conservation. However, if the price effect exceeded combined code and programmatic conservation, the amount of overlap was capped at 50%.

- Some wholesale customers have their own wells or surface water sources in addition to what they purchase from SPU. Water that wholesale customers expect to obtain from other sources of supply is subtracted from the forecast of their demand from the SPU system. This amount is currently about **19 mgd** and is projected to level off at **21 mgd** by 2040. Historically, Renton's water purchases from SPU have been negligible, but that is expected to change over time under the new contract as its demand begins to exceed its peak day capacity. Renton's estimated requirements from SPU are forecast to ramp up to 1 mgd by 2040. Highline states they plan to be purchasing 1 mgd from Lakehaven by 2019, augmenting their own groundwater supply and reducing demand from SPU.

Water Obtained from Other Sources of Supply in MGD: 2016-2040

	2016	2020	2030	2040
Cascade Total	9.1	9.3	9.8	9.8
Redmond	2.9	3.1	3.6	3.6
Skyway	0.3	0.3	0.3	0.3
Issaquah	1.4	1.4	1.4	1.4
Sammamish Plateau	4.5	4.5	4.5	4.5
F&P Total	9.8	10.8	11.0	11.5
Cedar River	0.1	0.1	0.1	0.1
Highline	1.8	2.7	2.7	2.7
Olympic View	0.4	0.4	0.4	0.4
WD 90	0.5	0.5	0.5	0.5
Renton	7.0	7.0	7.3	7.8
Total Wholesale	18.9	20.1	20.8	21.3

Sources: 2017 Survey of Wholesale Customers, Cascade Water Alliance Member Survey (Paula Anderson), direct communication with individual wholesale customers.

- Contract with the Cascade Water Alliance (Cascade). Under the Cascade contract as amended on May 30, 2013, Seattle will provide a fixed block of **33.3 mgd** to Cascade through 2039. The block will then be reduced by **2 mgd** per year for the three years beginning in 2040, and **1 mgd** per year thereafter until it reaches **5.3 mgd** in 2064. This has been incorporated into the forecast by subtracting the projected demand of Cascade members that are currently Seattle wholesale customers, and adding the Cascade block.

The following cities and districts are members of Cascade¹⁰:

- | | |
|------------|---------------------|
| ▪ Bellevue | ▪ Sammamish Plateau |
| ▪ Kirkland | ▪ Skyway |
| ▪ Issaquah | ▪ Tukwila |
| ▪ Redmond | |

- Block contract with Northshore Utility District. Northshore Utility District also has a block contract under which Seattle will reserve a fixed block of **8.6 mgd** for Northshore through the contract period which terminates in 2060. This has been incorporated into the forecast by subtracting Northshore's projected demand and adding the Northshore block. Note that current Northshore demand is about 3 mgd less than its block. By 2060, actual Northshore demand is expected to have grown to 7.4 mgd, still less than its block by more than 1 mgd.
- Forecasts of demand from potential new wholesale customers are based on data provided by them on their projected demand and existing supplies. In the past, Ames

¹⁰ Covington Water District left Cascade Water Alliance in 2012.

Lake Water Association, the City of Carnation, and the City of Snoqualmie expressed interest in becoming new wholesale customers and purchasing treated water from SPU and their potential demand was added to the 2013 WSP forecast. However more recently, only Ames Lake has maintained its expression of interest. Demand from Ames Lake is expected to begin at zero ramping up to 0.5 mgd by 2033 and remaining constant thereafter.

Source: email from Robert Pancoast, Ames Lake Water Association dated 12/13/2016.

Results

The water demand forecast remains considerably below SPU's current firm yield of 172 mgd through 2060. The demand forecast starts out at **130 mgd**, higher than actual demand in 2016 because the forecast includes the Cascade and Northshore blocks that currently exceed the actual demand of those customers by 9 mgd. Total demand is forecast to gradually increase to **136 mgd by 2039** and then decline with the initial reductions in Cascade's block. Water demand is then forecast to slowly decline for several years and then **stay relatively flat at about 132 mgd through 2060** as reductions in Cascade's block offset what would otherwise be a modest amount of growth in demand.

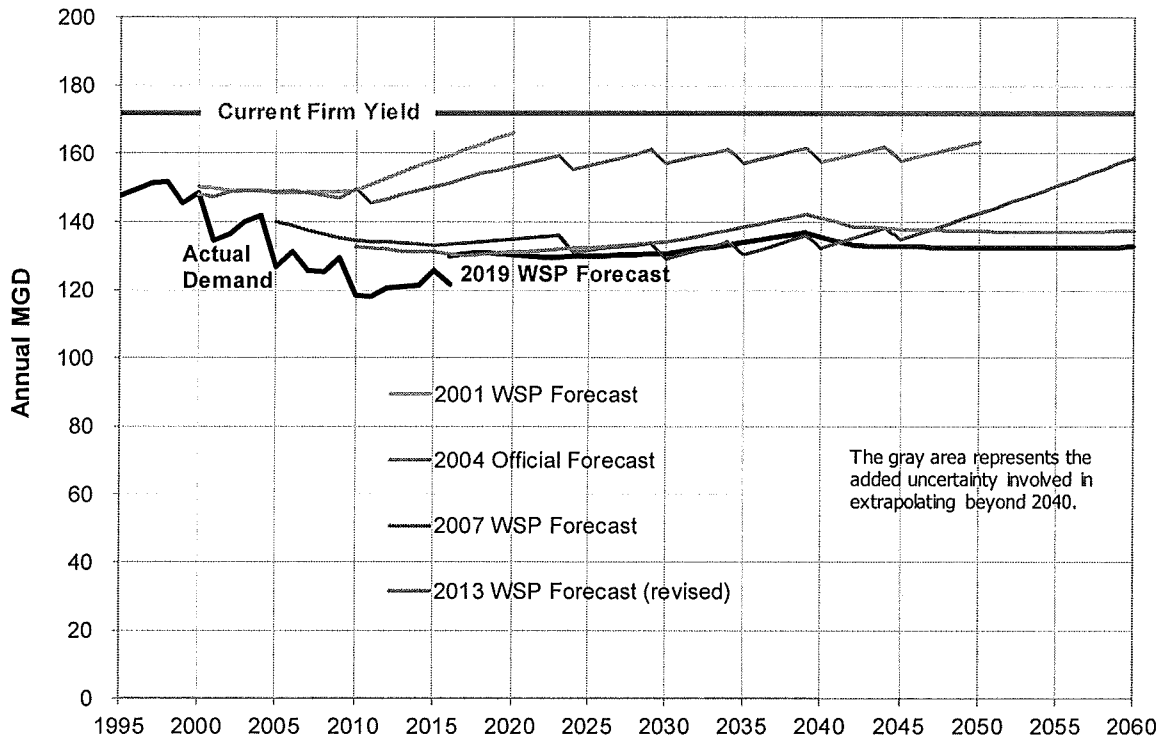
The 2017 Official Forecast broken down by sector is shown in the table and graphs below. The first graph shows the forecast of demand and supply out to 2060 along with previous WSP forecasts. The gray area between 2040 and 2060 represents the additional uncertainty involved in forecasting out more than 25 years. The second graph shows the various components that add up to the total demand forecast: Seattle retail, full and partial contract wholesale customers, the amounts specified in the Northshore and Cascade block contracts, and non-revenue water.

Components of Actual and Forecast Water Demand **All figures in millions of gallons per day (MGD)**

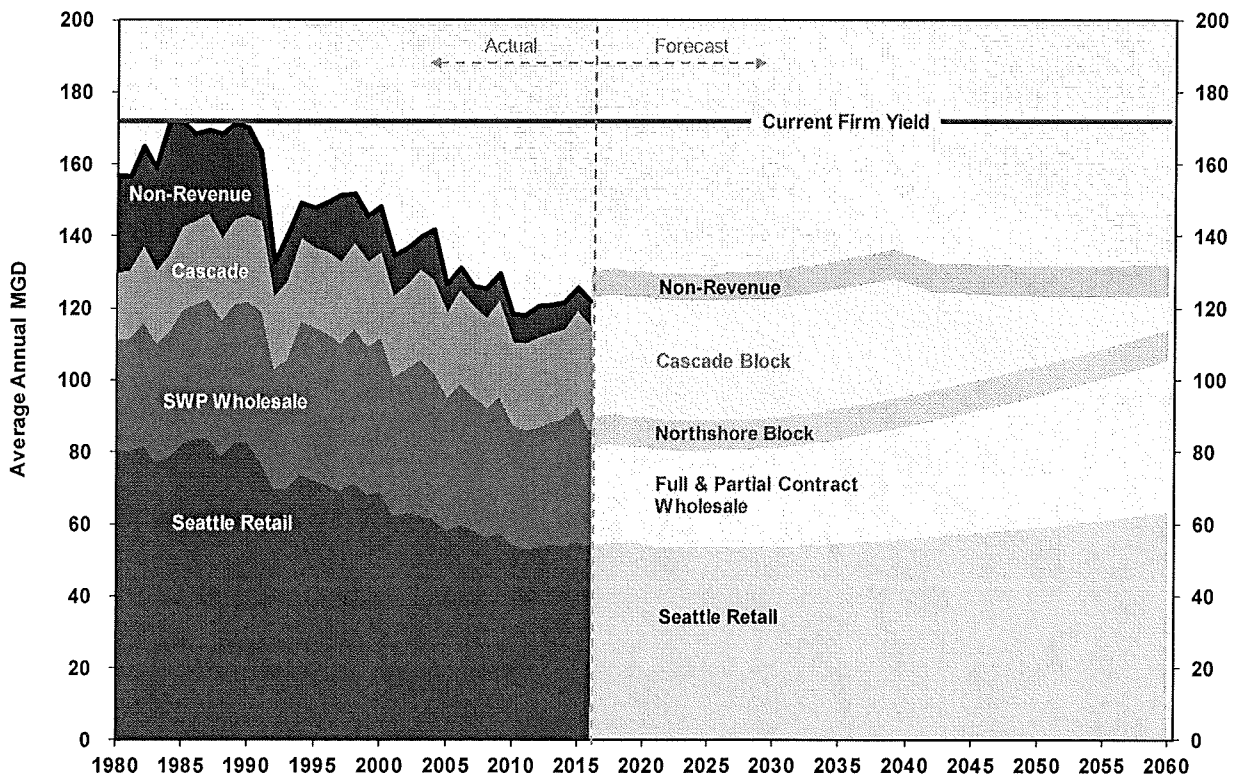
	Year	Billed Demand								Non-	Total System Demand	
		Seattle Retail				Wholesale				Revenue Water	Annual Average ²	Peak Day ⁴
		SF Res	MF Res	Non-Res	Subtotal	F&P ¹	Block ²	New ³	Subtotal			
A C T U A L	2000	26.9	14.5	27.7	69.1	34.3	31.7	0.0	66.0	13.2	148.2	241.9
	2001	24.0	13.7	24.6	62.3	31.4	29.3	0.0	60.7	11.6	134.6	204.0
	2002	24.8	13.1	24.9	62.8	32.8	31.2	0.0	63.9	9.8	136.5	222.6
	2003	24.9	12.8	24.6	62.3	35.2	33.1	0.0	68.2	9.4	139.9	250.2
	2004	24.2	12.5	24.6	61.3	33.3	33.2	0.0	66.5	14.0	141.7	246.8
	2005	22.6	12.2	23.2	58.1	30.1	30.8	0.0	60.9	7.7	126.7	210.4
	2006	23.6	12.3	23.7	59.6	32.0	33.3	0.0	65.3	6.3	131.2	236.8
	2007	22.7	12.0	23.6	58.3	30.5	31.9	0.0	62.4	5.2	125.9	227.6
	2008	22.0	11.8	22.5	56.2	29.3	31.5	0.0	60.8	8.2	125.3	202.0
	2009	23.2	11.6	22.6	57.4	30.7	34.0	0.0	64.7	7.5	129.5	241.9
	2010	21.4	11.4	21.6	54.4	26.6	29.4	0.0	56.0	8.0	118.4	197.9
	2011	20.5	11.2	21.2	52.9	26.9	30.5	0.0	57.4	7.6	117.9	177.7
	2012	20.9	11.4	21.3	53.7	26.8	31.3	0.0	58.0	8.8	120.5	200.6
	2013	21.0	11.5	21.6	54.1	27.3	31.6	0.0	58.9	7.9	120.9	189.6
	2014	20.8	11.3	21.5	53.6	28.1	32.2	0.0	60.3	7.6	121.5	196.4
	2015	21.4	11.5	22.7	55.6	29.7	33.6	0.0	63.3	6.7	125.6	212.1
	2016	20.6	11.6	22.2	54.3	28.5	32.3	0.0	60.8	6.6	121.7	194.7
F O R E C A S T	2016	20.7	11.6	22.0	54.3	26.6	41.9	0.0	68.5	7.0	129.9	259.7
	2017	20.7	11.6	22.3	54.6	27.1	41.9	0.0	69.0	7.1	130.7	261.4
	2018	20.7	11.7	22.6	55.0	26.9	41.9	0.0	68.8	7.1	130.9	261.7
	2019	20.5	11.8	22.5	54.8	26.7	41.9	0.0	68.5	7.2	130.5	261.0
	2020	20.2	11.9	22.5	54.6	26.8	41.9	0.0	68.7	7.2	130.5	260.9
	2021	19.9	11.8	22.3	54.0	26.7	41.9	0.0	68.6	7.3	129.8	259.7
	2022	19.7	11.7	22.4	53.9	26.6	41.9	0.1	68.5	7.3	129.7	259.4
	2023	19.6	11.7	22.6	53.8	26.6	41.9	0.1	68.6	7.4	129.7	259.4
	2024	19.4	11.6	22.7	53.7	26.7	41.9	0.2	68.7	7.4	129.8	259.6
	2025	19.3	11.6	22.8	53.6	26.8	41.9	0.2	68.8	7.4	129.9	259.8
	2026	19.2	11.6	22.9	53.6	26.9	41.9	0.2	69.0	7.5	130.1	260.1
	2027	19.0	11.5	23.0	53.6	27.0	41.9	0.3	69.1	7.5	130.2	260.5
	2028	18.9	11.5	23.1	53.6	27.1	41.9	0.3	69.3	7.6	130.4	260.8
	2029	18.8	11.5	23.2	53.6	27.2	41.9	0.3	69.4	7.6	130.6	261.2
	2030	18.7	11.5	23.4	53.6	27.3	41.9	0.4	69.6	7.7	130.8	261.7
	2031	18.6	11.6	23.6	53.8	27.6	41.9	0.4	69.9	7.7	131.4	262.7
	2032	18.6	11.6	23.7	53.9	27.9	41.9	0.5	70.2	7.8	131.9	263.9
	2033	18.5	11.7	23.9	54.1	28.2	41.9	0.5	70.6	7.8	132.5	265.1
	2034	18.5	11.8	24.1	54.4	28.5	41.9	0.5	70.9	7.8	133.1	266.2
	2035	18.4	11.9	24.3	54.6	29.0	41.9	0.5	71.3	7.9	133.8	267.6
	2036	18.4	11.9	24.5	54.8	29.4	41.9	0.5	71.8	7.9	134.5	269.1
	2037	18.3	12.0	24.7	55.1	29.9	41.9	0.5	72.2	8.0	135.3	270.5
	2038	18.3	12.1	24.9	55.3	30.3	41.9	0.5	72.7	8.0	136.0	272.0
	2039	18.3	12.2	25.1	55.6	30.8	41.9	0.5	73.1	8.1	136.8	273.5
	2040	18.2	12.3	25.3	55.8	31.3	39.9	0.5	71.6	8.1	135.5	271.1
5 Y R	2045	18.3	12.7	26.3	57.3	33.8	32.9	0.5	67.1	8.3	132.8	265.5
	2050	18.3	13.2	27.5	59.1	36.5	27.9	0.5	64.8	8.6	132.4	264.8
	2055	18.4	13.9	28.7	61.1	39.2	22.9	0.5	62.6	8.8	132.4	264.8
	2060	18.6	14.7	30.0	63.3	42.1	17.9	0.5	60.4	9.0	132.7	265.4

1. F&P refers to Full and Partial contracts wholesale customers.
2. The forecast of demand from Cascade Water Alliance (Cascade) and Northshore is equal to their blocks while the historical consumption data reflects water actually purchased from SPU by Cascade members and NUD. The blocks exceeded actual water purchases from SPU of Cascade members and NUD by 9.5 mgd in 2016.
3. Potential new wholesale customers (Ames Lake Water Association)
4. The forecast of peak day demand is based on a peak day factor of 2.0, the ratio of peak day to average annual demand in 2009 with a 5% allowance for hot, dry weather. The forecast of average annual demand under average weather conditions is multiplied by the peak day factor to estimate peak day demand with hot, dry weather.

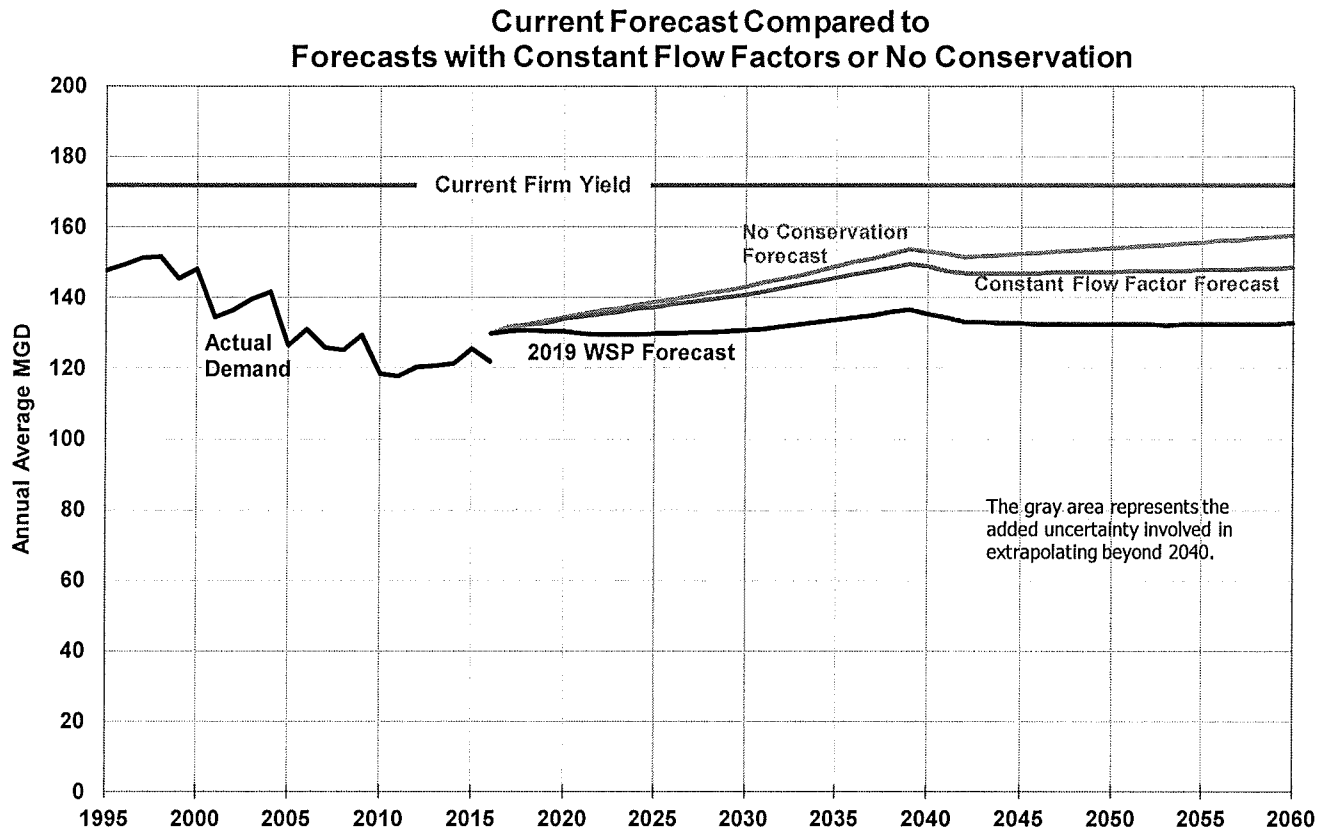
Current Forecast Compared to Earlier Forecasts



Components of Actual and Forecast Demand: 1980-2060

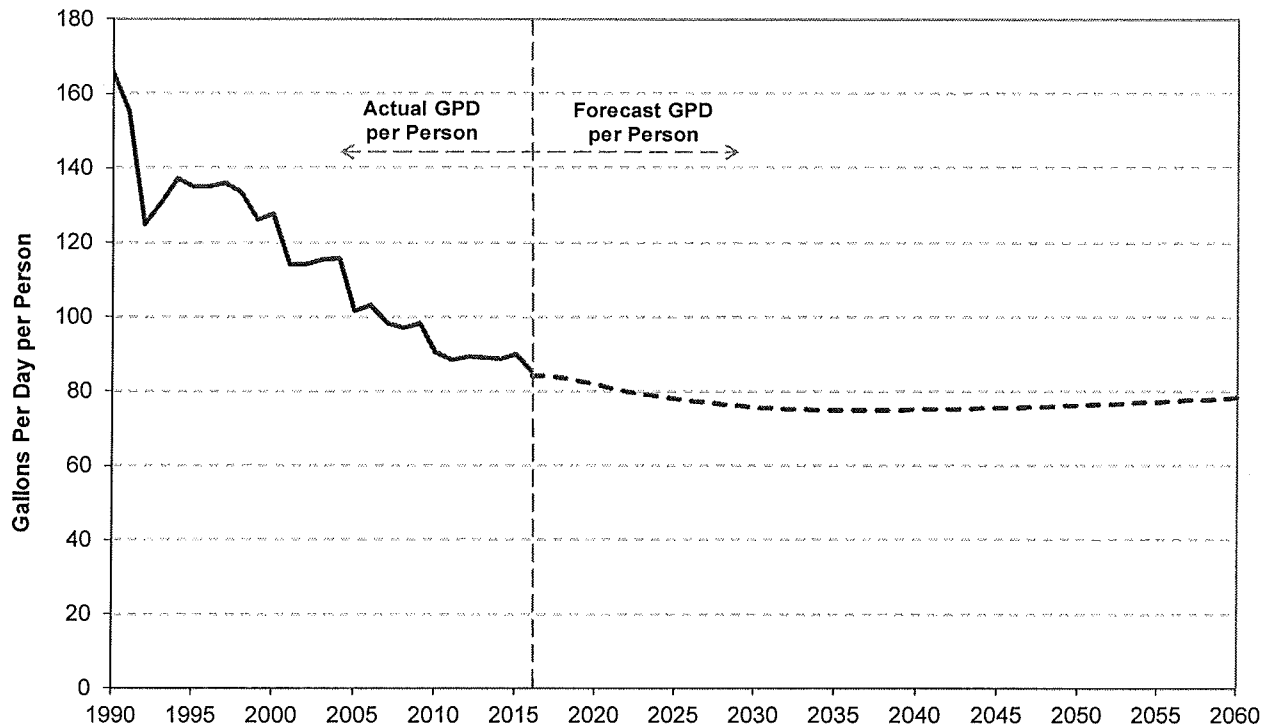


The graph below contrasts the official demand forecast with what it would be with constant flow factors and with no future conservation of any kind (i.e., no price effect, no code savings, and no programmatic savings). Note that the forecast with "no conservation" is slightly higher than the forecast holding water flow factors constant over time because the "no conservation forecast" includes the impact of income growth and changes in household size, which net to a small increase in flow factors. For the 2019 WSP forecast, all sources of conservation are estimated to produce a total reduction in water demand of about 25 mgd by 2060.



Finally, the implications of the new demand forecast for total system per capita water consumption are shown in the graph below. Due to anticipated programmatic conservation, code savings, and water and sewer rate increases, per capita consumption is forecast to continue declining over the next 20 years though at a slower rate than in the past. By 2033, per capita consumption is expected to level off at about 75 gpd (compared to 85 gpd currently) before slowly increasing after 2040 as the income effect begins to dominate the diminishing impacts of conservation. In contrast, between 1990 and 2016, total and per capita water consumption for Seattle and its non-Cascade wholesale customers declined 48% from 166 gallons per day (gpd) to 85 gpd.

**Actual & Forecast Water Consumption Per Capita:
Saving Water Partnership Customers**



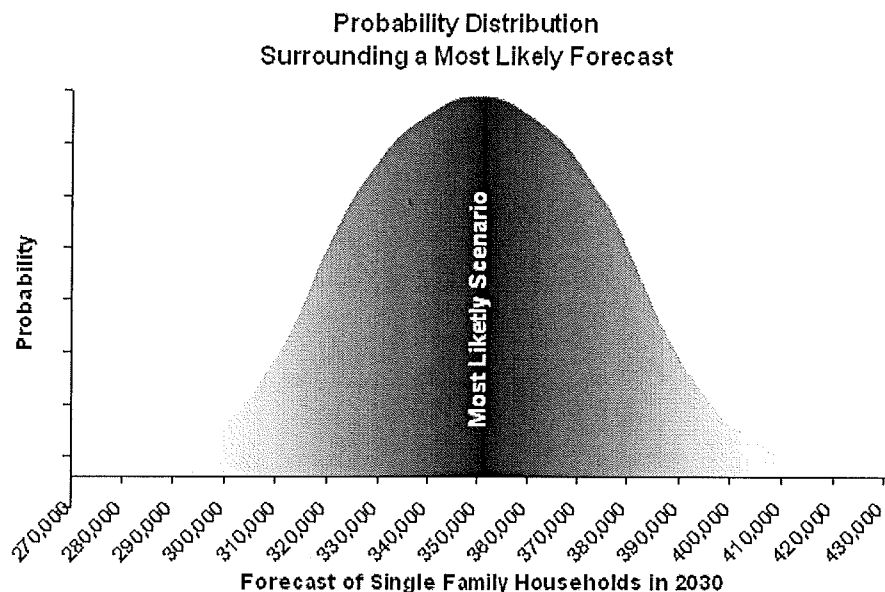
Forecast Uncertainty

What is most certain about a forecast out to 2060 is that it will be wrong. Actual demand in 2040 or 2060 is highly unlikely to be exactly what was forecast back in 2019. The official water demand forecast is itself based on forecasts of income, water prices, households and employment – all subject to uncertainty. Additional uncertainty surrounds the forecast model's assumptions about price and income elasticities, future conservation, wholesale customers' other sources of supply, and whether SPU will gain new customers and/or lose existing customers.

The Official Demand Forecast represents both SPU's policy intentions and its expectations of the future. However, it is prudent, especially in long-term planning, to consider the many uncertainties that could cause demand to be different from what's projected in the official forecast. These uncertainties fall into two categories – discrete and continuous – and are handled in two different ways.

The first category refers to those uncertainties that result from discrete events that produce significant and sometimes abrupt changes in customer demand. Discrete uncertainties represent occurrences that either happen or don't. They're on or off, yes or no (though there can be more than two conditions). An example of a discrete uncertainty is the block contract with Cascade Water Alliance. This and other discrete uncertainties are thought to be best handled by running individual "what-if scenarios" through the demand forecast model.

The second category consists of the continuous uncertainty that surrounds the various inputs to the model. An example would be the forecast of household growth. Actual growth over the forecast period could turn out to be lower or higher than forecast. These types of uncertainties can be represented by a continuous probability distribution around a mean or most likely value as illustrated below.



Modeling Continuous Uncertainty

A number of model inputs were identified as being subject to continuous uncertainty. (These are shown in the model structure flowchart on page 2 shaded in gray.) They include forecasts of single and multi-family households and employment; average annual growth rates for water prices and household income; price and income elasticities; the impact of code savings; and the extent to which price-induced conservation overlaps with code and programmatic conservation. Each uncertainty was modeled by specifying a probability distribution around the mean value of each variable. Many sources were consulted to define the range of uncertainty¹¹ and the shape of the distributions. The sources and assumptions used to characterize continuous uncertainties are outlined below.

Forecasts of Households and Employment: Two different sources were consulted to establish uncertainty ranges around the forecasts of long term demographic growth. In 2007 and again in 2012, the Washington State Office of Financial Management (OFM) produced high and low forecasts of population by county based on historical variability in net migration rates. Dick Conway and Associates developed high and low alternatives around the 2002 PSRC long term regional forecasts of population and employment (but not households) based on optimistic and pessimistic scenarios for the local and national economies¹². In earlier uncertainty analysis for the demand forecast, the greater geographical specificity of the OFM forecasts was combined with the more rigorous methodology and wider range between low and high provided by Dick Conway's analysis. Unfortunately, there have been no updates to Conway's uncertainty ranges since 2002. However, the latest set of OFM uncertainty ranges is very similar to the earlier set (2007). Therefore, the same uncertainty ranges for demographic variables used in the 2013 WSP forecast are used here after being calibrated to 2016 so that low, medium and high forecasts all start of from the same point. The ranges of uncertainty around the projections of households, employment and population used in the demand forecast model are shown in the table, below.

**Uncertainty Ranges Around Mean Values
Associated with High and Low Demographic Growth Scenarios**

	2030		2060	
	Low	High	Low	High
Single Family Households	-4%	6%	-9%	16%
Multifamily Households	-11%	18%	-25%	42%
Employment	-5%	8%	-12%	21%
Population	-8%	12%	-18%	30%

The ranges around single and multi-family households were derived from the reported high and low population values and the assumption that variability around the single family forecast is less than for the forecast of multifamily households. Note that the potential variation from forecast values is expected to be greater on the high side than on the low side.

Growth in the Price of Water: System water rates are obtained by dividing each year's projected revenue requirement by projected demand. Uncertainty about future water prices derives from variability in both of these terms. The baseline assumption is that after significant increases in water and sewer rates already adopted or anticipated through 2023,

¹¹ Each range is characterized by a high and low value representing two standard deviations from the mean.

¹² Scenarios developed by Global Insights, Inc.

growth in inflation-adjusted retail water rates will ramp down to 0.6% per year by 2025 and remain there through the forecast period. This is slower than the average historical rate of growth. The range of uncertainty around this is skewed very much on the high side, **minus 67% to plus 200%**, resulting in projected annual growth rates in real prices of between **0.2% and 1.8%**.

The model handles the impact on price of different levels of projected demand in a different way. Given the same set of revenue requirements, lower demand results in higher water prices and vice versa. That means that price effects would be expected to amplify swings in demand. For example, higher-than-projected demographic growth would cause demand to be higher than the official forecast, resulting in reduced prices and an additional boost in demand. The amount of the boost is determined by the price elasticity of demand and the amount by which prices fall. Incorporating this demand-price-demand-etc. feedback loop explicitly into the model isn't feasible because, as is explained in more detail below, the uncertainty analysis involves running 10,000 iterations of the demand model. However, the feedback loop has been approximated by widening the range of uncertainty around growth in households and employment. The amounts by which the ranges have been increased are **5.2%** on the high side and **5.3%** on the low side¹³.

Price Elasticity: The uncertainty ranges around price elasticity represent a synthesis of the various estimates of price elasticity reported in the literature review. These are **plus or minus 50%** for single and multi-family elasticities and **plus or minus 33%** around the non-residential elasticity.

Uncertainty Ranges Around Mean Price Elasticities

	Single Family	Multi- Family	Non- Residential
Low	-0.10	-0.05	-0.15
Mean	-0.20	-0.10	-0.225
High	-0.30	-0.15	-0.30

Growth in Real Household Income: There is some uncertainty about future growth in average income but much more uncertainty around the distribution of that growth. As explained above, there has been a decoupling of average and median income growth over the past 4 decades. While overall per capita income has averaged 1.8% annual growth since 1970, median income and in fact, the income of the bottom 90% of households has grown very little if at all in real terms. Practically all the growth in national income has gone to households at the very top of the income scale in the last 40 years - the top 10%, 1%, 0.1%, and 0.01% of households seeing their real incomes rise twofold, threefold, fivefold and eightfold, respectively. The baseline assumption in the demand forecast is that median income will grow at **0.9%** annually, about half the rate expected for average income. This scenario represents a slowing of the rate at which the distribution of income gets worse. The continuation of present trends with all income growth going to the top 10% and **zero** income growth for median households is the most pessimistic scenario in the uncertainty analysis. At the high end is the assumption that income grows proportionally across all households and the increasing skewness in the income distribution comes to a halt. Here, annual growth in average income equals that for median income equals **1.8%**.

¹³ These percents were obtained by calculating the percent changes in 2060 water prices that would result from the high and low growth scenarios relative to the baseline scenario and multiplying them by the average price elasticity.

Income Elasticity: As with price elasticity, the uncertainty band around income elasticity was derived from the various estimates of income elasticity in the literature review. A range of income elasticities from **0.19 to 0.35** (i.e., **plus or minus 30%**) around the mean value of 0.27 was chosen.

Savings from Code, Standards and Market Transformation (code): Code savings could be more or less than modeled. If market transformation towards fixtures and appliances that exceed code occurs slower than anticipated, code savings could be less than estimated for the baseline forecast. Alternatively, if additional codes are passed in the future, market transformation takes place more quickly, and green buildings become the norm for new construction, code savings could be more than estimated for the baseline forecast. A range of code savings from **9.5 to 22.3 mgd** (i.e., **plus or minus 40%**) around the mean value of 15.9 mgd was chosen.

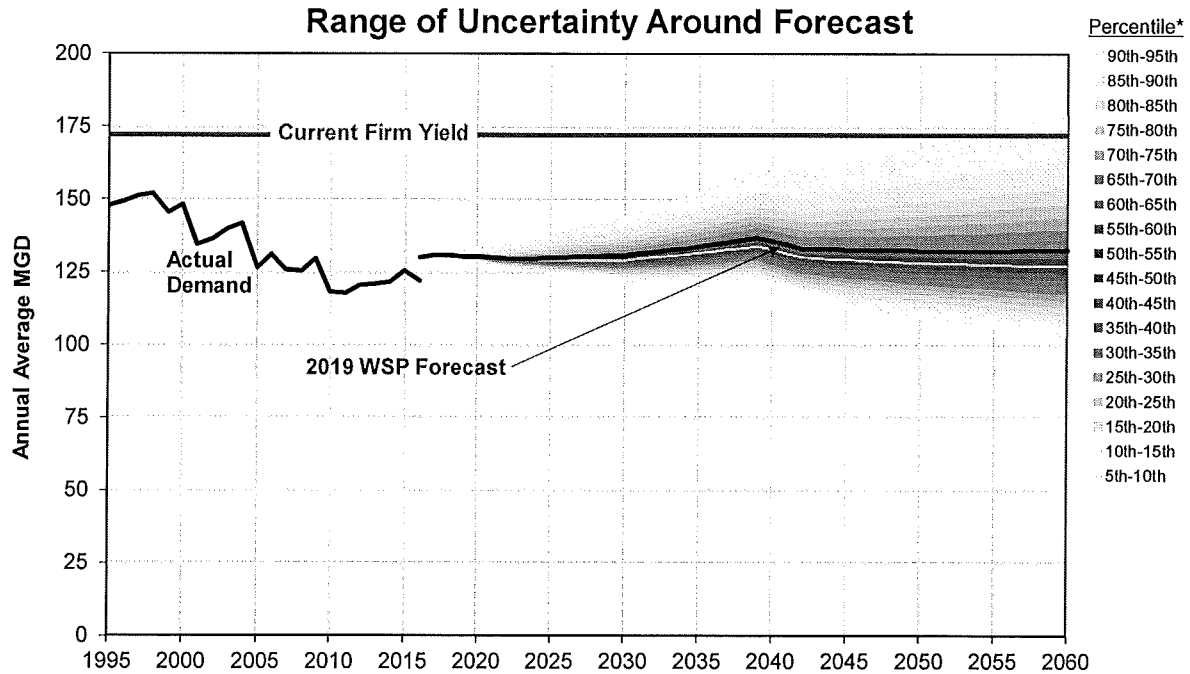
Modeling Uncertainty with @Risk: The uncertainty ranges described above are assumed to have normal or log-normal distributions,¹⁴ with the endpoint values representing two standard deviations from the mean. These probability distributions become inputs to an aggregate uncertainty model using @Risk software (an add-in to Excel) which employs Monte Carlo simulation to characterize uncertainty around the official demand forecast. During each individual run of the Monte Carlo simulation, a value is randomly selected for each input variable based on the probability density function specified for that variable¹⁵. Then, the complete set of input values for that iteration is used to produce a water demand forecast. The simulation procedure performs a large number (10,000) of independent iterations, each generating a separate demand forecast. These forecasts are then pooled to obtain a probability distribution of forecast water demand through 2060.

The results of the Monte Carlo simulation are displayed in the graph on the next page. The green bands indicate the range of uncertainty around the official forecast with each band representing a 5% change in probability. For example, the bottom of the lowest band represents the 5th percentile. That means it's estimated there's a 5% chance actual demand will be below that point (and, thus, a 95% chance it will be above). The top band is the 95th percentile which corresponds to an estimated 95% probability that actual demand will be below that point. Taking a cross-section of the graph at 2060 produces the probability distribution around the official forecast shown below.

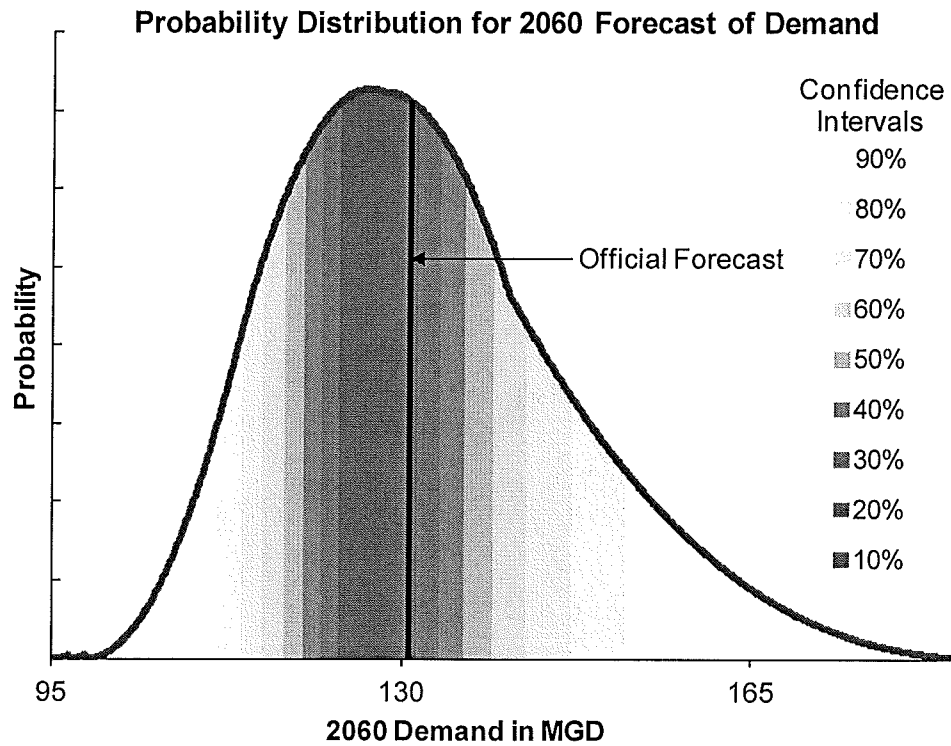
The uncertainty model represents a significant refinement over simply compounding all the high or all the low assumptions to create extreme high and extreme low scenarios. In the extreme high scenario, everything that could possibly cause demand to be higher than forecast is assumed to happen at the same time. The extreme low scenario is just the opposite with all low side assumptions applied simultaneously. These extreme scenarios overstate the actual uncertainty surrounding demand because they represent two highly unlikely combinations of events with essentially zero probability of occurring. The Monte Carlo simulation provides narrower bands of uncertainty and information about their estimated probabilities.

¹⁴ Log normal distributions are used for the uncertainty around household and employment growth and average annual rate of growth in water prices because the high and low ranges exhibit positive skewness (i.e., the highs are higher than the lows are low).

¹⁵ All variables with uncertainty are assumed to be independent except for growth in households and employment. These are linked in the model because they would be expected to move together.

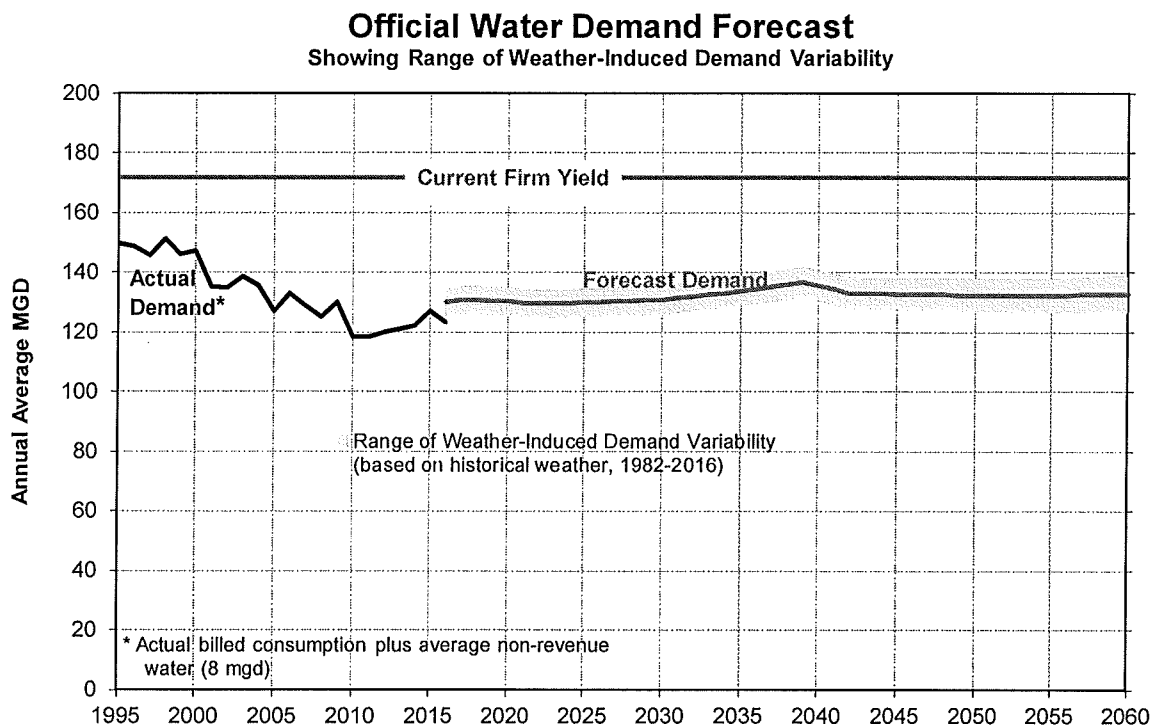


* Percentiles represent the probability that demand is less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth; price and income elasticities; and conservation. Note that the Official Forecast is at about the 60th percentile.



Implications: Given the current firm yield estimate for SPU's existing supply resources and the official demand forecast, a new source of supply will not be needed until well after 2060. Even when taking demand uncertainty as modeled above into consideration, there is more than a 90% probability that a new water source will not be necessary before 2060. This analysis does not explicitly calculate the possible impact of the "discrete" category of uncertainties mentioned in the introduction, nor the potential impacts of all possible sources of uncertainty. Some additional sources uncertainty that could affect future water demand but which have not been accounted for in the uncertainty analysis are described below.

Weather-Induced Demand Variability: Another source of "haziness" in the forecast is weather-induced demand variability. This is not strictly a matter of uncertainty however because there is no doubt that summer weather will continue to vary from year to year, and that this variation will cause water demand to fluctuate around the trend. Because base year flow factors are calculated from weather-adjusted consumption data, the forecast represents demand under average weather conditions. In any one year though, summer weather variability would be expected to boost or depress demand relative to the forecast under average weather. Analysis of daily consumption data back to 1982 shows a maximum variability of about plus or minus 5%. In other words, an extremely hot, dry summer would be expected to increase annual consumption *in that year* by up to 5% above the average trend. An extremely cool, wet summer would be expected to do the opposite, reducing that year's annual consumption by about 5% below the average trend. The amount by which actual demand is expected to be higher or lower than forecast due to variation in summer weather is shown as the blue band around the forecast in the graph below. Note this is based on historical weather variation and water use by customers. If the amount of weather variation around the average increases in the future due to climate change, the range of weather-induced demand variability might be expected to widen as well.



Climate Change: The water demand forecast model does not explicitly account for the potential impact of climate change on future demand, another source of future uncertainty. Climate modeling¹⁶ suggests that by 2060, what now represents the high end for daily high summer temperatures could be the average weather condition (i.e., approximately 80°F over the three summer months). This means that in its hottest and driest years, the region has already experienced what could become average weather in 40 or 50 years of future climate change. Assuming the relationship between summer weather and water demand in the future remains similar to what it is now,¹⁷ climate change might be expected to increase the forecast of *average-weather* water demand by approximately 5% over the forecast period, the upper end of the uncertainty band shown in the above graph of weather-induced demand variability under historic weather conditions. However, the climate models also project that weather variability will increase over time with a wider spread of summer temperatures from year to year. So, while climate change is not expected to bump *average* demand higher by more than the current range of weather-induced demand variability, weather variability – and therefore demand variability – will likely be greater in the future with wider fluctuations from year to year, again assuming no change in customer water use behavior.

The global impact of climate change could also bring about other significant but hard-to-predict changes to local water demand. For example, the Pacific Northwest could attract large numbers of people migrating from areas of the world hit harder by the deleterious effects of climate change. Loss of agricultural capacity worldwide could boost the importance of urban agriculture in the region and the demand for irrigation water. On the other hand, technological innovations in how we use water and energy could significantly reduce the demand for water from SPU's existing sources. Accounting for these types of uncertainty are beyond the scope of this analysis.

¹⁶ The PUMA project, referenced in Section 2.4.1.3 of the WSP, involved downscaling climate projections from 20 different Global Climate Models (GCMs) run with two greenhouse gas emissions scenarios – one high (RCP8.5) and one low (RCP 4.5) – to several point locations in the Central Puget Sound region. Averaging the projections for SeaTac Airport from the 20 models using the high emissions scenario (RCP8.5) indicates that average air temperatures will be approximately 80 degrees Fahrenheit over in the June through August time period by 2060. Note that since this is the average of the high emissions projections, some of the models predict even higher increases in summer temperatures by 2060.

¹⁷ Of course, that relationship could change and get stronger or weaker over time. On the one hand, the widespread practice of allowing lawns to go brown could become untenable as higher temperatures result in grass dying rather than going dormant without irrigation. On the other hand, hotter drier summers could induce people to plant more drought-tolerant landscaping or prod compensating public policies, programs or other efforts to help dampen water demand.

SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-2
Water Right Self-Assessment

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Seattle Public Utilities
Water Right Self-Assessment Form for Water System Plan
March 2018

Water Right Permit, Certificate, or Claim # *If water right is interruptible, identify limitation in yellow section below	WFI Source # If a source has multiple water rights, list each water right on separate line	Existing Water Rights Qi= Instantaneous Flow Rate Allowed (GPM or CFS) Qa= Annual Volume Allowed (Acre-Feet/Year) This includes wholesale water sold				Current Source Production – Most Recent Calendar Year 2016 Qi = Max Instantaneous Flow Rate Withdrawn (GPM or CFS) Qa = Annual Volume Withdrawn (Acre-Feet/Year) This includes wholesale water sold				10-Year Forecasted Source Production (determined from WSP) This includes wholesale water sold 2028				20-Year Forecasted Source Production (determined from WSP) This includes wholesale water sold 2038			
		Primary Qi Maximum Rate Allowed	Non-Additive Qi Maximum Rate Allowed	Primary Qa Maximum Volume Allowed	Non-Additive Qa Maximum Volume Allowed	Total Qi Maximum Instantaneous Flow Rate Withdrawn	Current Excess or (Deficiency) Qi	Total Qa Maximum Annual Volume Withdrawn	Current Excess or (Deficiency) Qa	Total Qi Maximum Instantaneous Flow Rate in 10 Years	10-Year Forecasted Excess or (Deficiency) Qi	Total Qa Maximum Annual Volume in 10 Years	10-Year Forecasted Excess or (Deficiency) Qa	Total Qi Maximum Instantaneous Flow Rate in 20 Years	20-Year Forecasted Excess or (Deficiency) Qi	Total Qa Maximum Annual Volume in 20 Years	20-Year Forecasted Excess or (Deficiency) Qa
1. S1-068624CL	01 CEDAR RIVER Cedar River and Chester Morse Lake	Not specified (note 1)		138,898 AF/Yr (note 1)		280 CFS (181 MGD)		89,454 AF/yr									
2. S1-068623CL	01 CEDAR RIVER Lake Youngs	N/A		33,770 Acre-Feet (Storage)		N/A		N/A									
3. R1-00748C	02 TOLT RIVER South Fork Tolt Reservoir	N/A		57,830 Acre-Feet (Storage)		N/A		N/A									
4. S1-10602P	02 TOLT RIVER South Fork Tolt Diversion	280 CFS (181 MGD)		168,000 AF/yr		85 CFS (55 MGD)		47,408 AF/yr									
5. G1-24621P (temporary permit)	03 RIVERTON HTS #1 05 RIVERTONHTS #2 06 RIVERTON HTS WF	4,000 GPM (5.8 MGD)		Not specified		0		0									
6. G1-24619P (temporary permit)	04 BOULEVARD	4,000 GPM (5.8 MGD)		Not specified		0		0									
7. S1-28477P	Rainwater Harvesting (note 2)	N/A		23,150 AF/yr		N/A		N/A									
	TOTALS =	(see note 1)		306,898 AF/yr excludes storage, wells and rainwater harvesting		365 CFS (236 MGD)	---	136,862 AF/yr (122 MGD)	170,036 AF/yr excludes storage, wells and rainwater harvesting	400 CFS (259 MGD) MDD assuming 2*ADD	---	144,946 AF/yr (129.4 MGD)	161,952 AF/yr excludes storage, wells and rainwater harvesting	418 CFS (270 MGD) MDD assuming 2*ADD	---	151,219 AF/yr (135.0 MGD)	155,679 AF/yr excludes storage, wells and rainwater harvesting
Column Identifiers for Calculations:		A		B		C	=A-C	D	=B-D	E	=A-E	F	=B-F	G	=A-G	H	=B-H

PENDING WATER RIGHT APPLICATIONS: Identify any water right applications that have been submitted to Ecology.						
Application Number	New or Change Application?	Date Submitted	Quantities Requested			
			Primary Qi	Non-Additive Qi	Primary Qa	Non-Additive Qa
1. S1-*04254 North Fork Tolt River Diversion	New, held in abeyance	7/14/1936	280 CFS			
2. G1-27384 Snoqualmie Aquifer	New	1/19/1994	41,600 GPM			
3. S1-27877 Snoqualmie River	New	1/29/1998	100 CFS		72,000 AF/yr	
4. G1-24619 Boulevard Park	New	3/7/1985	4,000 GPM To be modified to 2,900 GPM		2,200 AF/yr To be modified to 1,200 AF/yr	
5. G1-24620 Glacier Well	New	3/7/1985	4,000 GPM		2,200 AF/yr	
6. G1-24621 Riverton Heights	New	3/7/1985	4,000 GPM To be modified to 6,300 GPM		2,200 AF/yr To be modified to 3,200 AF/yr	
7. G1-24824 Riverton Heights	New	4/14/1986	4,000 GPM		2,200 AF/yr	
8. G1-24825 Boulevard Park	New	4/14/1986	4,000 GPM		2,200 AF/yr	
9. R1-28168 Aquifer Storage	New	6/29/2005	N/A		4,800 AF (storage)	

ADDITIONAL COMMENTS:

Note 1: Cedar River Claim is for a total Qa of 336,650 AF/yr, with no stated Qi. Under the 2006 Agreement with the Muckleshoot Indian Tribe, the City of Seattle agreed to limit diversions to 124 million gallons per day on an annual average basis (138,898 AF/yr) and to donate the portion of the perfected water right above this amount to the Washington State Trust Water Right Program. CS1-068624CL Trust Water Right Temporary Donation provides for 22,403 AF/yr, the amount that has been perfected through diversions at Landsburg, to be donated to the Washington State Trust Water Right Program to benefit instream flows in the Cedar River.

Note 2: Permit S1-28477P allows for rainwater harvested from rooftops to be stored in tanks, cisterns or rain barrels and used on site for non-potable municipal purposes. Place of use includes properties in the City of Seattle's retail service area that are served by the combined and partially combined sewer systems, but not those served by just the sanitary sewer system. Reporting is to occur with Water System Plan updates; see Attachment 1.

Seattle Public Utilities does not use interties as a normal supply source.

**Seattle Public Utilities
2019 Water System Plan
Appendix A-2, Attachment 1**

RAINWATER HARVESTING USE REPORT

March 2018

Permit S1-28477P allows for rainwater harvested from rooftops to be stored in tanks, cisterns or rain barrels and used on site for non-potable municipal purposes. Reporting is to occur with Water System Plan updates, and is to include the location, purpose of use, roof size, and storage capacity of each system, as well as total number of systems in operation.

Larger Systems in Operation

Table 1 shows larger rainwater harvesting systems currently in operation within the permitted place of use. These systems are large facilities that Seattle Public Utilities is aware of that meet the conditions of the permit. Other facilities, especially smaller systems, may also exist that meet the criteria of the permit, that SPU does not have data to report on at this time.

**Table 1
Large Rainwater Systems in Operation**

	Location	Purpose of Use	Roof Size (square feet)	Storage Capacity (gallons)
1	600 4 th Ave. (City Hall)	Toilet flushing Irrigation	42,898	224,400
2	950 NW Carkeek Park Rd. (Carkeek Park Environmental Learning Center)	Toilet flushing Irrigation	2,640	3,850
	TOTAL		45,538 (1 acre)	225,250

RainWise Facilities

SPU's RainWise program, which was established in April 2010, provides financial assistance to homeowners who install rainwater harvesting devices, such as cisterns and rainbarrels, that contribute to SPU's goal of reducing combined sewer overflows. The cisterns and rainbarrels installed under this program may also be used to collect rainwater for **irrigation** purposes. Table 2 below lists the facilities that have been installed under this program in the permitted place of use.

Table 2
RainWise Program Facilities
Installed 2010-2016

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
1	8331 Jones Ave NW	Rain Garden & Cistern	950.0		497.0	200	23-Sep-10
2	2839 NW 67th St	Rain Garden & Cistern	1,720.0		410.0	200	14-Oct-10
3	7529 19th Ave NW	Rain Garden & Cistern	1,486.0		776.0	1,000	04-Nov-10
4	8071 Earl Ave NW	Rain Garden & Cistern	1,872.0		936.0	200	16-Nov-10
5	2811 NW 80th Street	Cistern overflowing to Rain Garden	1,010.0		1,010.0	550	07-Dec-10
6	7047 Earl Ave NW	Cistern overflowing to back to Sewer	588.0	588.0		200	14-Dec-10
7	8323 28th Ave NW	Rain Garden & Cistern	1,348.0		1,133.0	200	16-Dec-10
8	7558 28th Ave NW	Rain Garden & Cistern	1,239.0		729.0	200	21-Dec-10
9	8319 28th Ave NW	Cistern	896.0	896.0		200	11-Jan-11
10	2837 NW 68th St	Rain Garden & Cistern	909.0		438.0	200	20-Jan-11
11	8017 16th Ave NW	Cistern overflowing to back to Sewer	532.0	532.0		200	17-Feb-11
12	7525 17th Ave NW	Rain Garden & Cistern	1,315.0		284.0	55	01-Mar-11
13	7530 23rd Ave NW	Rain Garden & Cistern	749.0		450.0	200	08-Mar-11
14	2807 NW 68th St	Rain Garden & Cistern	1,168.0		456.0	200	14-Mar-11
15	2703 NW 73rd St	Cistern	1,470.0	1,470.0		1,235	12-May-11
16	6750 27th Ave NW	Cistern overflowing to Conveyance Furrow	1,701.0	1,701.0		820	17-May-11
17	7540 30th Ave NW	Cistern overflowing to back to Sewer	1,681.0	1,681.0		820	27-Jun-11
18	8035 26th Ave NW	Rain Garden & Cistern	1,168.0		600.0	200	21-Jul-11
19	6511 23rd Ave NW	Cistern overflowing to Rain Garden	1,149.0		1,149.0	410	04-Aug-11
20	8060 23rd Ave NW	Rain Garden & Cistern	766.0		226.0	200	27-Sep-11
21	8012 21st Ave NW	Rain Garden & Cistern	1,028.0		497.0	200	27-Sep-11
22	7727 26th Ave NW	Cistern overflowing to Rain Garden	1,269.0		1,269.0	615	01-Oct-11
23	7559 Jones Ave NW	Rain Garden & Cistern	982.0		945.0	620	12-Oct-11
24	6737 27th Ave NW	Cistern overflowing to back to Sewer	2,229.0	2,229.0		820	12-Oct-11
25	7703 26th Ave NW	Rain Garden & Cistern	1,540.0		1,363.0	1,030	28-Oct-11
26	6516 Jones Ave NW	Rain Garden & Cistern	1,011.0		944.0	400	08-Nov-11
27	7713 26th Ave NW	Rain Garden & Cistern	1,621.0		1,223.0	620	17-Nov-11
28	7723 27th Ave NW	Cistern overflowing to back to Sewer	1,424.0	1,424.0		600	01-Dec-11
29	7056 19th Ave NW	Rain Garden & Cistern	801.0		453.0	200	21-Dec-11
30	7303 22nd Ave NW	Cistern overflowing to Rain Garden	1,763.0		1,763.0	620	04-Jan-12
31	3002 75th Ave NW	Cistern overflowing to Conveyance Furrow	1,497.0	1,497.0		600	04-Jan-12
32	24th Ave NW	Rain Garden & Cistern	1,885.0		1,023.0	1,235	02-Feb-12
33	6552 24th Ave NW	Cistern overflowing to Rain Garden	1,518.0		1,518.0	1,030	07-Feb-12
34	2832 NW 73rd St	Rain Garden & Cistern	1,331.0	255.0	1,076.0	820	17-Feb-12

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
35	3002 NW 68th St	Cistern overflowing to Conveyance Furrow	738.0	738.0		200	29-Feb-12
36	7553 27th Ave NW	Cistern	1,793.0	1,793.0			29-Feb-12
37	7341 22nd Ave NW	Cistern overflowing to back to Sewer	427.0	427.0		200	29-Feb-12
38	2843 NW 67th St	Rain Garden & Cistern	1,404.0		702.0	200	08-Mar-12
39	7322 17th Ave NW	Cistern overflowing to Rain Garden	819.0		819.0	410	05-Apr-12
40	7545 Earl Ave NW	Rain Garden & Cistern	1,647.0	600.0	1,047.0	1,440	10-Apr-12
41	6542 21s Ave NW	Rain Garden & Cistern	630.0	420.0		820	19-Apr-12
42	7506 Jones Ave NW	Rain Garden & Cistern	872.0		420.0	200	08-May-12
43	7322 Jones Ave NW	Cistern overflowing to Rain Garden	1,439.0		1,439.0	615	10-May-12
44	7710 27th Ave NW	Rain Garden & Cistern	1,105.0		600.0	620	22-May-12
45	7056 23rd Ave NW	Cistern overflowing to back to Sewer	1,542.0	1,542.0		620	05-Jun-12
46	6714 21st Ave NW	Cistern overflowing to Rain Garden	1,083.0		1,083.0	200	06-Jun-12
47	2428 NW 56th St	Cistern overflowing to back to Sewer	1,966.0	1,966.0		1,745	21-Jun-12
48	8200 34th Ave NW	Cistern	986.0	986.0		400	10-Jul-12
49	3224 NW 59th St	Cistern	1,825.0	1,825.0			17-Jul-12
50	6540 18th Ave NW	Cistern	993.0	993.0		620	19-Jul-12
51	9033 13th Avenue SW	Rain Garden & Cistern	1,624.0		128.3	1,000	23-Jul-12
52	2034 NW 60th St	Rain Garden & Cistern	2,308.0	638.0	1,670.0	1,435	02-Aug-12
53	2846 NW 63rd Street	Rain Garden & Cistern	936.0		936.0	200	25-Sep-12
54	7030 38th Avenue NE	Cistern	615.0	615.0		200	02-Oct-12
55	2836 NW 62nd Street	Cistern	1,380.0	1,380.0		200	05-Oct-12
56	7358 25th Avenue NW	Rain Garden & Cistern	1,339.0		475.0	205	12-Oct-12
57	8045 17th Avenue NW	Rain Garden & Cistern	1,740.0		702.0		24-Nov-12
58	6520 Jones Avenue NW	Rain Garden & Cistern	1,716.0		1,098.0	410	29-Nov-12
59	5057 37th Avenue NE	Cistern overflowing to Rain Garden	1,465.0		1,465.0	200	04-Dec-12
60	7043 Jones Avenue NW	Rain Garden & Cistern	1,368.0	667.0		205	04-Dec-12
61	6512 23rd Avenue NW	Rain Garden & Cistern	5,000.0		760.0	410	06-Dec-12
62	7326 Jones Avenue NW	Cistern overflowing to Rain Garden	1,393.0		1,393.0	825	11-Dec-12
63	7525 31st Avenue NW	Cistern	1,448.0	1,448.0		1,690	11-Dec-12
64	7752 20th Avenue NW	Rain Garden & Cistern	1,440.0		500.0	205	18-Dec-12
65	6804 28th Avenue NW	Rain Garden & Cistern	1,335.0		210.0	205	18-Dec-12

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
66	7533 29th Avenue NW	Rain Garden & Cistern	1,468.0		731.0	205	20-Dec-12
67	6045 43rd Avenue NE	Cistern overflowing to back to Sewer	2,436.0	2,436.0		1,145	27-Dec-12
68	6709 Earl Avenue NW	Rain Garden & Cistern	2,567.0	749.0		530	14-Jan-13
69	3850 NE 85th Street	Rain Garden & Cistern	1,954.0	678.0	663.0	735	24-Jan-13
70	7359 20th Avenue NW	Rain Garden & Cistern	1,792.0	645.0		530	24-Jan-13
71	3037 NW 73rd Street	Cistern	1,325.0		502.0	205	30-Jan-13
72	4312 NE 60th Street	Cistern overflowing to back to Sewer	1,033.0	1,033.0		1,060	14-Feb-13
73	9018 13th Avenue SW	Cistern overflowing to Rain Garden	981.3		981.3	600	21-Feb-13
74	8016 20th Avenue NW	Rain Garden & Cistern	1,100.0		167.0	205	28-Feb-13
75	5746 37th Avenue NE	Rain Garden & Cistern	1,271.5		901.0	50	12-Mar-13
76	2633 NW 64th Street	Rain Garden & Cistern	1,717.0		397.0	205	02-Apr-13
77	6541 Jones Avenue NW	Rain Garden & Cistern	4,028.8	2,004.3	2,024.5	4,520	02-Apr-13
78	5518 Ann Arbor Avenue NE	Rain Garden & Cistern	1,839.8	650.0		530	04-Apr-13
79	7707 19th Avenue NW	Cistern overflowing to back to Sewer	830.5	830.5		530	09-Apr-13
80	3220 NW 74th Street	Cistern overflowing to back to Sewer	1,320.0	1,320.0		1,060	11-Apr-13
81	5004 38th Avenue NE	Rain Garden & Cistern	2,215.0	735.0		205	16-Apr-13
82	7538 27th Ave NW	Cistern overflowing to Rain Garden	1,676.0		1,676.0	530	21-May-13
83	7715 Jones Avenue NW	Cistern overflowing to Rain Garden	1,550.0		1,290.0	1,145	21-May-13
84	5816 Ann Arbor Ave NE	Rain Garden & Cistern	2,171.0	674.0		265	06-Jun-13
85	3911 NE 82nd Street	Cistern overflowing to back to Sewer	455.0	455.0		205	01-Jul-13
86	7737 16th Avenue NW	Cistern	753.0	753.0		205	09-Jul-13
87	3164 NE 84th Street	Rain Garden & Cistern	1,515.7	476.0		205	23-Jul-13
88	6556 37th Avenue NE	Rain Garden & Cistern	2,079.0	1,170.0	909.0	1,735	31-Jul-13
89	7738 34th Ave NW	Cistern	2,805.2				15-Aug-13
90	3216 NE 80th Street	Rain Garden & Cistern	1,272.6	696.1		205	20-Aug-13
91	8021 31st Avenue NE	Cistern overflowing to Rain Garden	933.5		933.5	205	21-Aug-13
92	3116 NE 81st St	Cistern overflowing to back to Sewer		447.8		205	27-Aug-13
93	7700 21st Ave NW	Cistern overflowing to Rain Garden	1,097.5		1,097.5	530	24-Sep-13

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
94	7035 Jones Avenue NW	Rain Garden & Cistern	1,877.8		1,877.8	410	07-Oct-13
95	3016 NW 58th Street	Rain Garden & Cistern	902.0		412.5	205	07-Oct-13
96	9038 14th Ave SW	Cistern overflowing to Rain Garden	2,798.5		1,346.0	840	31-Oct-13
97	4303 NE 56th St	Rain Garden & Cistern	1,935.3	710.0		205	12-Nov-13
98	7048 17th Ave SW	Cistern overflowing to back to Sewer	472.0			420	31-Dec-13
99	2817 E. Park Drive	Cistern overflowing to back to Sewer	942.0	942.0		795	22-Jan-14
100	1131 NW 65th St	Cistern overflowing to back to Sewer	586.8	586.8		205	23-Jan-14
101	7757 21st Ave NW	Cistern overflowing to back to Sewer	1,644.0	1,644.0		940	06-Feb-14
102	1840 E. Hamlin St	Cistern overflowing to Conveyance Furrow	728.0	728.0		265	15-Apr-14
103	3007 NW 72nd St	Cistern overflowing to Rain Garden	996.0		996.0	510	01-May-14
104	5816 S Pilgrim St	Rain Garden & Cistern	3,075.4		1,996.5	410	20-May-14
105	4829 NE 75th St	Cistern overflowing to Rain Garden	986.0		986.0	865	21-May-14
106	6833 44th Ave NE	Rain Garden & Cistern	1,578.3	750.0		265	22-May-14
107	9749 Arrowsmith Ave S	Cistern overflowing to Conveyance Furrow	1,641.0	1,641.0		410	30-Jul-14
108	6038 S Pilgrim St	Cistern	3,025.0	3,025.0		1,025	30-Jul-14
109	6023 S Roxbury St	Cistern overflowing to back to Sewer	1,684.0	1,684.0		615	07-Aug-14
110	9035 12th Ave SW	Cistern overflowing to Rain Garden	1,984.0		1,984.0	830	14-Aug-14
111	3046 NW 61st St	Rain Garden & Cistern	1,134.0		469.8	205	28-Aug-14
112	1504 SW Trenton St	Cistern overflowing to back to Sewer	2,409.0	2,409.0		615	29-Aug-14
113	1500 SW Trenton	Cistern overflowing to Rain Garden	1,931.0		1,931.0	410	16-Sep-14
114	5215 38th Ave NE	Cistern overflowing to back to Sewer	1,364.0	1,364.0		470	25-Sep-14
115	326 N 45th St						02-Oct-14
116	2432 NW 63rd St	Rain Garden & Cistern	1,526.8		763.4	265	07-Oct-14
117	4615 Aurora Ave N	Cistern overflowing to Rain Garden	1,145.0		1,145.0	1,320	07-Oct-14
118	5529 S. Morgan St	Cistern overflowing to back to Sewer	1,681.0	1,681.0		1,715	22-Oct-14
119	7532 Earl Ave NW	Rain Garden & Cistern	1,045.3		527.0	205	23-Oct-14
120	7711 13th Ave SW	Cistern overflowing to Conveyance Furrow	1,634.0	1,634.0		615	28-Oct-14
121	6710 20th Ave NW	Rain Garden & Cistern	1,232.5		1,232.5	1,060	30-Oct-14
122	3036 NW 69th St	Rain Garden & Cistern	1,044.0		384.0	265	04-Nov-14
123	1500 SW Myrtle St.	Cistern	2,003.5	2,003.5		410	20-Nov-14
124	4607 S. Chicago St	Cistern	2,076.0	2,076.0		930	24-Nov-14

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
125	10621 68th Ave S	Cistern overflowing to back to Sewer	2,018.0	2,018.0		615	25-Nov-14
126	7350 16th Ave NW	Cistern	481.0	481.0		265	09-Dec-14
127	2115 NW 75th St	Cistern overflowing to Rain Garden	1,497.3		1,497.3	530	09-Dec-14
128	8652 17th Ave SW	Cistern	625.0	625.0		530	15-Dec-14
129	6716 17th Ave NW	Cistern overflowing to Rain Garden	1,414.0		707.0	265	16-Dec-14
130	5501 37th Ave NE	Cistern overflowing to Rain Garden	1,119.5		1,119.5	625	18-Dec-14
131	7941 48th Ave S	Cistern overflowing to back to Sewer	1,546.0	1,546.0		615	24-Dec-14
132	6556 52nd Ave NE	Cistern	1,722.2	1,722.2		1,060	02-Jan-15
133	9421 18th Ave SW	Rain Garden & Cistern	2,152.0	560.0		205	08-Jan-15
134	3610 Ashworth Ave N	Cistern	460.0	460.0		430	13-Jan-15
135	7951 16th Ave SW	Cistern	704.0	704.0		205	20-Jan-15
136	8309 49th Ave S	Cistern overflowing to Rain Garden	1,503.0		1,503.0	205	27-Jan-15
137	7929 50th Ave S	Cistern overflowing to Rain Garden	1,727.1		1,182.6	410	10-Feb-15
138	10256 Renton Ave S	Cistern overflowing to back to Sewer	1,120.0	1,120.0		205	10-Feb-15
139	8323 Renton Ave S	Cistern	1,327.0	1,327.0		265	10-Feb-15
140	9656 Waters Ave S	Cistern overflowing to back to Sewer	7,225.0	7,225.0		4,605	10-Feb-15
141	1220 SW Orchard St	Rain Garden & Cistern	1,820.0		702.0	205	17-Feb-15
142	7813 48th Ave S	Cistern overflowing to Rain Garden	1,904.0		1,904.0	205	17-Feb-15
143	4440 S. Warsaw St.	Cistern	1,500.0	1,500.0		410	17-Feb-15
144	4432 S. Warsaw St.	Cistern	1,522.0	1,522.0		615	17-Feb-15
145	6326 47th Ave S	Cistern overflowing to back to Sewer	2,158.0	2,158.0		615	24-Feb-15
146	7920 46th Ave S	Cistern overflowing to Rain Garden	905.0		905.0	520	10-Mar-15
147	6545 40th Ave NE	Cistern overflowing to Rain Garden	1,484.0		1,484.0	530	31-Mar-15
148	8100 32nd Ave SW	Cistern overflowing to Rain Garden	1,620.0		1,620.0	205	31-Mar-15
149	7047 50th Ave NE	Cistern				470	17-Apr-15
150	1620 SW Austin	Rain Garden & Cistern	1,940.0				23-Apr-15
151	1626 SW Austin St	Rain Garden & Cistern	1,889.0	849.0		205	01-May-15
152	6320 47th Ave S	Rain Garden & Cistern	2,878.7	1,850.0		940	05-May-15
153	5218 Greenwood Ave N	Cistern	1,492.5			530	12-May-15
154	5602 30th Ave NW	Cistern	1,197.5	1,197.5		410	19-May-15
155	5420 57th Ave S	Cistern overflowing to back to Sewer	861.5	861.5		530	19-May-15
156	3856 41st Ave S	Rain Garden & Cistern	1,522.5	652.5		530	19-May-15
157	4614 S Chicago	Cistern overflowing to Rain Garden	750.8		750.8	625	02-Jun-15

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
158	1504 SW Trenton	Cistern	2,409.0			515	16-Jun-15
159	9403 18th Ave SW	Cistern overflowing to back to Sewer	2,789.4	2,789.4		2,170	16-Jun-15
160	10064 Arrowsmith Ave S	Cistern	1,525.5	1,525.5		1,395	30-Jun-15
161	9751 62nd St	Rain Garden & Cistern	2,513.0		988.0	865	30-Jun-15
162	2851 NW 64th St	Cistern	546.0	546.0		410	02-Jul-15
163	9306 Lima Terrace S	Cistern	1,161.5	1,161.5		1,525	21-Jul-15
164	4804 S Snoqualmie St	Cistern	1,020.0	1,020.0		865	21-Jul-15
165	5241 S Graham St	Cistern overflowing to back to Sewer	1,660.0	1,660.0		1,060	21-Jul-15
166	9334 53rd Ave S	Cistern overflowing to back to Sewer	975.5	975.5		410	28-Jul-15
167	8021 29th Ave NW	Rain Garden & Cistern	1,102.5		204.0	410	28-Jul-15
168	5039 49th Ave S	Cistern	790.0	790.0		420	04-Aug-15
169	4120 48th ave s	Cistern	2,064.0	2,064.0		675	04-Aug-15
170	6502 51st Ave S	Rain Garden & Cistern	1,055.0	435.0		205	11-Aug-15
171	1853 E Hamlin St	Cistern	1,012.0	1,012.0		410	18-Aug-15
172	4255 Graham St	Cistern	1,675.0	1,675.0		615	18-Aug-15
173	4255 Graham St	Cistern	1,675.0			615	18-Aug-15
174	6908 46th Ave S	Cistern overflowing to back to Sewer	1,632.0	1,632.0		410	25-Aug-15
175	4004 50th Ave NE	Cistern	1,284.0	1,284.0		735	25-Aug-15
176	9224 14th Ave SW	Cistern	899.0	899.0		530	01-Sep-15
177	6044 51st Ave NE	Cistern overflowing to back to Sewer	936.5	936.5		265	01-Sep-15
178	7943 46th Ave S	Cistern	1,316.0	1,316.0		530	15-Sep-15
179	8314 19th Ave NW	Cistern	540.0	540.0		630	22-Sep-15
180	7310 23rd Ave NW	Cistern	672.0	672.0		265	22-Sep-15
181	4610 S. Holly Street	Cistern	2,597.0	2,597.0		675	22-Sep-15
182	6548 NE Windermere Rd	Cistern overflowing to back to Sewer	1,062.0	1,062.0		410	29-Sep-15
183	8038 30th Ave NW	Cistern	1,569.0	1,569.0		470	30-Sep-15
184	4302 NE 56th St	Cistern overflowing to back to Sewer	522.5	522.5		205	05-Oct-15
185	6030 28th Ave NE	Cistern	680.0	680.0		205	07-Oct-15
186	7551 22nd Ave NW	Rain Garden & Cistern	1,275.0		945.0	735	08-Oct-15
187	6549 40th Ave NE	Cistern	1,580.0	1,580.0		1,060	15-Oct-15
188	7542 16th Ave NW	Rain Garden & Cistern	1,001.0		512.0	265	21-Oct-15
189	8059 Loyal Way NW	Rain Garden & Cistern	839.0		839.0	735	22-Oct-15
190	4335 Baker Ave NW	Cistern	1,259.0	1,259.0		1,060	23-Oct-15
191	2847 NW 64th St	Cistern	1,402.0	1,402.0		530	26-Oct-15
192	4920 NE 65th St	Rain Garden & Cistern	2,407.0	999.0	1,408.0	950	29-Oct-15
193	6128 S Pilgrim St	Cistern overflowing to back to Sewer	3,496.0	3,496.0		2,630	30-Oct-15
194	6739 21st Ave NW	Rain Garden & Cistern	1,828.5		1,828.5	205	02-Nov-15
195	5134 S Morgan St	Cistern overflowing to back to Sewer	795.0	795.0		205	05-Nov-15
196	4242 S Frontenac St	Cistern	1,540.0	1,540.0		470	09-Nov-15

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
197	6230 Wilson Ave S	Cistern overflowing to back to Sewer	1,440.5	1,440.5		410	12-Nov-15
198	7519 S Taft St	Cistern overflowing to back to Sewer	1,899.0	1,899.0		795	17-Nov-15
199	10200 63rd Ave S	Rain Garden & Cistern	1,306.0		706.0	265	23-Nov-15
200	7753 33rd Ave NW	Cistern overflowing to back to Sewer	1,309.0	1,309.0		470	24-Nov-15
201	1209 N 46th St	Cistern	1,230.0	1,230.0		530	11-Dec-15
202	5509 NE 63rd St	Rain Garden & Cistern	1,401.3	869.5		205	15-Dec-15
203	6548 21st Ave NW	Cistern overflowing to back to Sewer	619.0	619.0		265	22-Dec-15
204	1025 N 36th St	Cistern overflowing to back to Sewer	1,295.0	1,295.0		1,060	07-Jan-16
205	7316 56th Ave NE	Cistern	2,236.0	2,236.0		1,060	13-Jan-16
206	4609 49th Ave S	Cistern	898.0	898.0		625	19-Jan-16
207	8838 15th Ave SW	Cistern overflowing to back to Sewer	1,312.5	1,312.5		1,060	02-Feb-16
208	4106 Woodland Park Ave N	Cistern overflowing to back to Sewer	471.0	471.0		205	04-Feb-16
209	4203 NE 74th St	Cistern overflowing to back to Sewer	2,052.0	2,052.0		1,060	08-Feb-16
210	5526 S. Holly St	Rain Garden & Cistern	1,413.0		645.0	1,440	09-Feb-16
211	5218 38th Ave NE	Cistern overflowing to Rain Garden	972.0		466.0	205	18-Feb-16
212	7046 55th Ave NE	Cistern overflowing to Conveyance Furrow	1,364.0	1,364.0		820	19-Feb-16
213	4013 NE 62nd St	Rain Garden & Cistern	1,695.0		1,695.0	530	23-Feb-16
214	4015 Dayton Ave S	Cistern	418.5	418.5		205	03-Mar-16
215	6048 40th Ave NE	Cistern overflowing to back to Sewer	1,124.5	1,124.5		530	03-Mar-16
216	6219 47th Ave S	Cistern	1,067.0	1,067.0		530	10-Mar-16
217	5727 S Cooper St	Cistern	1,634.0	1,634.0		840	14-Mar-16
218	5149 S Graham St	Cistern overflowing to back to Sewer	1,521.0	1,521.0		840	14-Mar-16
219	7018 50th Ave NE	Cistern	3,627.0	3,627.0		1,420	15-Mar-16
220	4425 41st Ave S	Cistern overflowing to Rain Garden	945.0	425.0		205	16-Mar-16
221	4742 48th Ave NE	Cistern overflowing to Conveyance Furrow	1,992.0	1,992.0		1,110	17-Mar-16
222	6607 58th Ave NE	Cistern overflowing to back to Sewer	1,558.5	1,558.5		1,060	23-Mar-16
223	3023 NW 64th St	Cistern overflowing to back to Sewer	1,507.5	1,507.5		1,060	23-Mar-16
224	7555 22nd Ave NW	Cistern overflowing to back to Sewer	577.0	577.0		205	01-Apr-16
225	4246 NE 74th St	Cistern overflowing to back to Sewer	488.0	488.0		205	01-Apr-16
226	7721 28th Ave NW	Cistern overflowing to back to Sewer	1,594.0	1,594.0		615	01-Apr-16

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
227	604 N 39th St	Cistern overflowing to back to Sewer	488.0	488.0		265	01-Apr-16
228	4230 Greenwood Ave N	Cistern overflowing to back to Sewer	613.0	613.0		205	01-Apr-16
229	5817 28th Ave NW	Cistern overflowing to back to Sewer	672.0	672.0		205	04-Apr-16
230	6043 44th Ave NE	Rain Garden & Cistern	1,946.0	559.0	752.0	1,060	18-Apr-16
231	6050 44th Ave NE	Cistern overflowing to back to Sewer	462.0	462.0		530	20-Apr-16
232		Cistern overflowing to back to Sewer	949.0	949.0		205	21-Apr-16
233	5503 NE 63rd St	Cistern overflowing to back to Sewer	585.0	585.0		205	21-Apr-16
234	6003 17th Ave NW	Cistern overflowing to back to Sewer	2,011.0	2,011.0		615	21-Apr-16
235	3668 Dayton Ave N	Cistern overflowing to back to Sewer	949.0	949.0		205	21-Apr-16
236	11439 71st Pl S	Cistern overflowing to back to Sewer	799.0	799.0		530	25-Apr-16
237	6706 Earl Ave NW	Cistern overflowing to back to Sewer	461.0	461.0		205	26-Apr-16
238	405 N 41st St	Cistern overflowing to back to Sewer	750.0	750.0		865	27-Apr-16
239	4905 S Rose St	Rain Garden & Cistern	1,617.0	808.5		205	29-Apr-16
240	4317 S Holden St	Cistern overflowing to back to Sewer	1,850.0	1,850.0		1,680	11-May-16
241	2356 N 61st St	Rain Garden & Cistern	1,271.0	488.5		205	23-May-16
242	4623 46th Ave S	Cistern	1,050.0	1,050.0		820	06-Jun-16
243	7703 22nd Ave NW	Rain Garden & Cistern	1,162.0		553.0	205	10-Jun-16
244	6825 47th Ave NE	Rain Garden & Cistern	1,165.0	689.0		265	13-Jun-16
245	7728 25th Ave NW	Rain Garden & Cistern	919.0		457.0	265	29-Jun-16
246	7324 56th Ave NE	Cistern overflowing to back to Sewer	1,021.0	1,021.0		1,060	30-Jun-16
247	5735 S Cooper St	Cistern	1,562.0	1,562.0		410	01-Jul-16
248	4103 Francis Ave N	Cistern overflowing to back to Sewer	1,485.0	1,485.0		1,325	05-Jul-16
249	3841 Interlake Ave N	Rain Garden & Cistern	1,407.0	660.0		205	06-Jul-16
250	2828 NW 69th St		792.0		483.0	205	06-Jul-16
251	4757 23rd Ave SW		1,529.0	1,529.0		1,060	13-Jul-16
252	813 N 43rd St	Cistern overflowing to back to Sewer	1,062.0	1,062.0		410	14-Jul-16
253	4916 S Angeline St	Cistern	3,436.0	3,436.0		2,420	18-Jul-16
254	7719 27th Ave NW	Rain Garden & Cistern	1,190.0		1,190.0	470	19-Jul-16
255	1275 SW Orchard St	Cistern overflowing to back to Sewer	1,426.0	1,426.0		530	20-Jul-16
256	6703 17th Ave NW	Cistern	1,664.0	1,664.0		410	25-Jul-16
257	4610 46th Ave S	Cistern overflowing to back to Sewer	1,293.0	1,293.0		840	09-Aug-16
258	2456 24th Ave E	Cistern overflowing to back to Sewer	1,165.0	1,165.0		410	09-Aug-16

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
259	8112 11th Ave SW	Rain Garden & Cistern	1,362.0		1,362.0	205	10-Aug-16
260	3415 36th Ave S	Cistern overflowing to back to Sewer	1,036.0	1,036.0		840	23-Aug-16
261	9421 14th Ave SW	Cistern overflowing to back to Sewer	834.0	834.0		205	23-Aug-16
262	4208 3rd Ave NW	Cistern overflowing to back to Sewer	1,470.0	1,470.0			31-Aug-16
263	4710 S Ferdinand St	Cistern overflowing to back to Sewer	1,250.3	1,250.3		530	06-Sep-16
264	6119 47th Ave S	Cistern overflowing to back to Sewer	1,486.0	1,486.0		265	06-Sep-16
265	6121 47th Ave S	Cistern overflowing to back to Sewer	1,159.5	1,159.5		530	06-Sep-16
266	6017 47th Ave S	Cistern overflowing to back to Sewer	1,412.0	1,412.0		410	06-Sep-16
267	4800 49th Ave S	Cistern overflowing to back to Sewer	1,703.0	1,703.0		1,680	14-Sep-16
268	4800 49th Ave S	Cistern overflowing to Conveyance Furrow	1,703.0	1,703.0		1,680	14-Sep-16
269	6610 46th Ave S	Cistern overflowing to back to Sewer	1,653.0	1,653.0		530	20-Sep-16
270	5919 S Roxbury St	Cistern overflowing to back to Sewer	1,410.0	1,410.0		410	20-Sep-16
271	4034 Dayton Ave N	Cistern	725.0	725.0		265	21-Sep-16
272	1802 SW Elmgrove St	Cistern overflowing to back to Sewer	917.0	917.0		410	21-Sep-16
273	1838 E Shelby St	Cistern	1,742.0	1,742.0		410	22-Sep-16
274	9800 59th Ave S	Rain Garden & Cistern	1,330.0		1,330.0	205	22-Sep-16
275	8300 21st Ave NW	Rain Garden & Cistern	1,076.5		514.0	205	28-Sep-16
276	4112 41st Ave S	Cistern overflowing to back to Sewer	1,092.0	1,092.0		1,150	29-Sep-16
277	9823 63rd Ave S	Cistern	1,292.0	1,292.0		530	04-Oct-16
278	5739 S. Cooper St	Rain Garden & Cistern	1,748.3	1,748.3		1,260	05-Oct-16
279	7316 Jones Ave NW	Rain Garden & Cistern	1,437.0	1,437.0		840	05-Oct-16
280	4031 Francis Ave N	Cistern overflowing to back to Sewer	780.0	780.0		1,060	11-Oct-16
281	3819 38th Ave S	Cistern overflowing to back to Sewer	1,300.0	1,300.0		530	25-Oct-16
282	5814 22nd Ave NW	Cistern	6,281.0	6,281.0		5,650	25-Oct-16
283	9757 61st Ave S						26-Oct-16
284	5015 S Brandon St	Cistern overflowing to back to Sewer	689.0	689.0		420	01-Nov-16
285	4511 Cascadia Ave S	Cistern overflowing to Conveyance Furrow	1,144.0	1,144.0		530	01-Nov-16
286	3042 NW 64th St	Cistern overflowing to Conveyance Furrow	1,066.0	1,066.0		410	02-Nov-16
287	4420 2nd Ave NW	Cistern overflowing to back to Sewer	1,625.0	1,625.0		1,060	02-Nov-16
288	4219 Ashworth Ave N	Rain Garden & Cistern	1,956.0		1,601.0	205	16-Nov-16

#	Site Address	Type of Facility	Roof Square Footage to Facility	Roof Square Footage to Cistern	Roof Square Footage to Cistern to Rain Garden	Cistern Total Gallons	Date of Post Inspection
289	8207 31st Ave NE	Cistern overflowing to Rain Garden	1,008.3		1,008.3	530	16-Nov-16
290	5500 NE 63rd St	Cistern overflowing to Rain Garden	1,619.0		652.0	530	16-Nov-16
291	4219 Ashworth Ave N	Rain Garden & Cistern	1,956.0		1,601.0	205	16-Nov-16
292	6518 27th Ave NW	Cistern overflowing to back to Sewer	1,559.5	1,559.5		470	22-Nov-16
293	7556 40th Ave NE		1,150.0				22-Nov-16
294	5131 S Frontenac St	Cistern overflowing to back to Sewer	1,360.0	1,360.0		820	23-Nov-16
295	4201 37th Ave S	Rain Garden & Cistern	1,240.0		1,240.0	420	23-Nov-16
296	4632 44th Ave S	Cistern	768.0	768.0		960	23-Nov-16
297	9271 Ithaca Pl S	Cistern overflowing to back to Sewer	868.0	868.0		265	23-Nov-16
298	4226 46th Ave S	Cistern overflowing to back to Sewer	542.5	542.5		205	29-Nov-16
299	1616 SW Elmgrove St	Cistern overflowing to back to Sewer	1,325.0	1,325.0		660	01-Dec-16
300	5117 S Lucile St	Cistern	931.0	931.0		1,060	06-Dec-16
301	8022 20th Ave NW	Cistern overflowing to back to Sewer	478.5	478.5		205	07-Dec-16
302	3029 NW 59th St	Cistern	1,554.5	1,554.5		530	07-Dec-16
303	5516 40th Ave NE	Rain Garden & Cistern	2,020.0	730.0		205	12-Dec-16
304	3213 E Alder St	Cistern overflowing to back to Sewer	1,930.0	1,930.0		2,185	13-Dec-16
305	7723 13th Ave SW	Cistern overflowing to back to Sewer	1,647.3	1,647.3		1,260	13-Dec-16
306	5121 S Medley Ct	Cistern	1,802.0			530	20-Dec-16
307	6610 46th Ave S						20-Dec-16
308	8324 19th Ave NW	Cistern overflowing to back to Sewer	516.8	516.8		530	22-Dec-16
309	8322 48th Ave S						28-Dec-16
310	141 Euclid Ave	Cistern overflowing to back to Sewer	1,694.0	1,694.0		865	28-Dec-16
310	Sum totals		434,821.8 (10 acres)	253,632.2	101,294.3	186,535	

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-3
Groundwater Elevations at Seattle Well Fields

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Groundwater Elevations at Seattle Well Fields

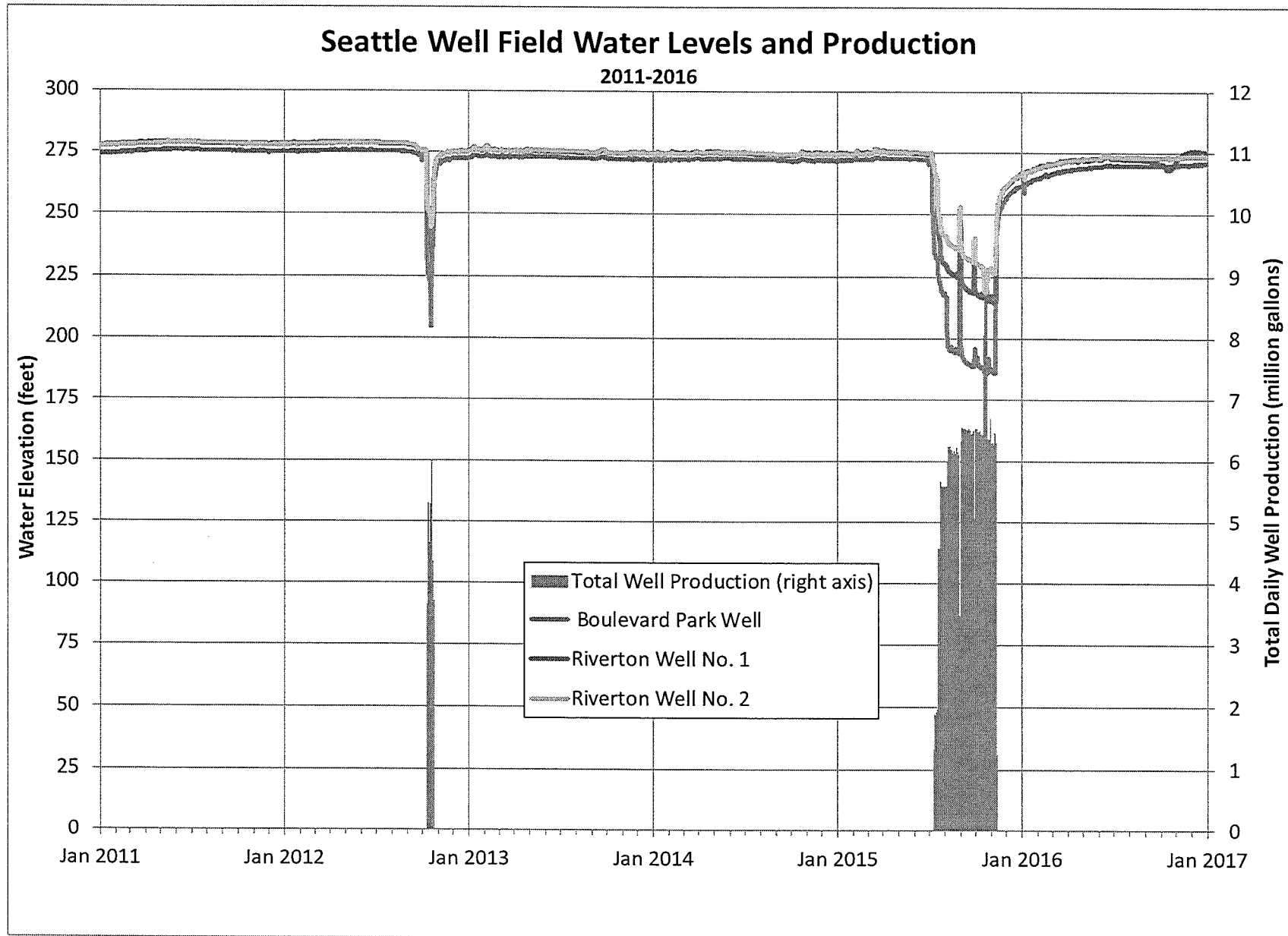
September 2017

SPU monitors groundwater levels in the vicinity of the Riverton and Boulevard Park Well Fields as part of its management of this supply source. Underlying the area are three water-bearing, sand and gravel formations now known as the Shallow, Intermediate and Deep Aquifers. The aquifers are arranged in layers and separated by much less pervious silt and clay layers which act as aquitards. At the land surface, over much of the area, is a highly-compacted layer composed of glacial till. SPU has three production wells tapped into the Intermediate Aquifer.

In addition to the production wells, SPU has a network of six monitoring wells in the Well Fields. Three of these wells can monitor water levels in the intermediate aquifer, two in the shallow aquifer, and one in the deep aquifer. Data loggers collected continuous elevation data from the monitoring wells from late 1991 through late 1999, primarily during and immediately after the ASR demonstration project. In the absence of recharge operations, it was felt that levels recorded continuously in the three production wells by the SCADA system would adequately track trends in the intermediate aquifer. Routine collection of water level data from the observation wells was suspended in early 2000, but was reactivated in 2015 during and after pumping to collect data for calibration of a groundwater model to support water rights permitting. Data are available from this system starting in January 2003 and from SPU's I-SCADA IMS Data Portal starting in April 2005.

The graph below shows the groundwater elevations from the SCADA system at the Riverton and Boulevard Park productions wells from January 2011 through December 2016. Also shown in the graph is total daily production from the three wells. No long-term trends appear in the data. Short-term declines occurred in 2012 and 2015 when the wells were used, but levels quickly recovered when pumping ceased.

SPU will continue to monitor the elevations in the production wells for any trends, and will re-activate the monitoring well network if recharge operations are undertaken.



SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-4
Monthly Production Data by Source

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Monthly Production Data by Source
Average Monthly Production in million gallons per day

	2011				2012				2013			
	Cedar	Tolt	Wells	Total	Cedar	Tolt	Wells	Total	Cedar	Tolt	Wells	Total
January	62	42	0	105	66	38	0	103	67	36	0	103
February	64	39	0	103	64	38	0	102	68	36	0	104
March	68	37	0	104	67	37	0	104	67	37	0	104
April	65	40	0	106	65	39	0	104	56	47	0	103
May	64	44	0	108	68	50	0	117	64	56	0	120
June	68	55	0	123	66	55	0	121	76	65	0	141
July	76	68	0	144	88	56	0	144	98	74	0	172
August	96	67	0	163	103	67	0	170	98	64	0	162
September	86	59	0	146	91	61	0	151	73	53	0	126
October	71	38	0	108	60	58	2	120	65	41	0	106
November	67	37	0	104	68	38	0	106	65	37	0	102
December	65	37	0	102	66	35	0	101	64	39	0	103
Total	71	47	0	118	73	48	0	121	72	49	0	121

	2014				2015				2016			
	Cedar	Tolt	Wells	Total	Cedar	Tolt	Wells	Total	Cedar	Tolt	Wells	Total
January	59	42	0	101	66	36	0	102	69	33	0	102
February	65	35	0	100	65	36	0	102	68	34	0	102
March	62	39	0	100	67	37	0	104	66	36	0	101
April	62	41	0	102	68	37	0	105	67	45	0	111
May	68	50	0	118	82	46	0	128	85	45	0	130
June	75	69	0	144	105	70	0	175	98	51	0	149
July	95	78	0	173	110	77	3	190	101	53	0	154
August	96	69	0	165	96	65	6	166	111	56	0	168
September	80	56	0	136	74	41	6	122	84	47	0	131
October	69	40	0	109	66	36	7	109	70	38	0	109
November	69	37	0	106	66	37	2	104	70	32	0	102
December	66	35	0	101	60	41	0	101	66	37	0	102
Total	72	49	0	121	77	47	2	126	80	42	0	122

Note: Sums of amounts shown may not equal Total due to rounding.

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-5
Water Reclamation Evaluation Checklist

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King County

For questions, call Kristina Westbrook,
King County Reclaimed Water Program Manager at (206) 296-5279
www.kingcounty.gov/reclaimedwater

Water Reclamation Evaluation Checklist For Systems with 1,000 or more Connections

The County and State recognize that changing conditions could initiate a need to respond in new ways to future water quality standards, wastewater discharge requirements, take advantage of advances in treatment technologies and/or allow our region to be positioned to respond to changes associated with climate change and population growth.

In 2003, Chapter 90.46 of the Revised Code of Washington (RCW) was amended to require public water systems serving 1,000 or more connections to evaluate opportunities for reclaimed water when completing their water system plans. Please use this checklist to meet King County consistency requirements in responding to this legislation.

Please use this checklist, including the inventory template, to ensure that your water system plan includes sufficient information about opportunities for reclaimed water and your system's efforts to develop those opportunities. If a question is not applicable or the information is unavailable, then answer, "unknown" or "n/a." King County will consider the checklist completed if each answer is filled in with the best available information, even if the utility states that it is not aware of any reclaimed water opportunities within its service area.

Water System Name: Seattle Public Utilities
Date: 3/1/2018
PWS ID# 77050 Y
Contact: Joan Kersnar

1. **Identifying Potential Future Demand for Reclaimed Water:** King County maintains a database and map of potential reclaimed water users for evaluating future projects. Please use the template below, or similar table, to provide information to assist King County in further researching these potential uses.

• **Large Utility Water Users (choose one):**

- ☐ Attached is an inventory of twenty large (above 20,000 gallons/month on average), non single-family residential, water users served by our utility that have a potential for reclaimed water use, or
- ☒ Attached is an inventory of our utility's top twenty water users, or
- ☐ The information requested is unknown or not available.

Additional Comments: _____

• **Large Self Suppliers (choose one):**

- ☐ Attached is an inventory of large, self-supplied water users within our water utility's service boundaries - especially those near wastewater treatment plants, mainlines, outfalls, and pump stations or similar reclaimed water facilities), or
- ☒ The information requested is unknown or not available.

Additional Comments: _____

• **Other (choose one):**

- ☐ Attached is an inventory of other water users (such as those that are clustered near one another and could be served by a single system) that may be likely candidates for reclaimed water use, or
- ☐ The information requested is unknown or not available.

Additional Comments: See SPU, "An Economic Analysis of the North Seattle Reclaimed Water Project," September 2010.

2. **Environmental Commitment:** Are you a city/town, or providing water service to a city/town, that has made commitments within resource management plans, salmon recovery plans, or other environmental initiatives for which there is a potential opportunity for using reclaimed water to assist in meeting commitments? (choose one)

☐ Yes, here are plans that have potential for reclaimed water use in our service area to meet the above commitments:

☒ The information requested is unknown, not available.

Additional Comments: _____

3. **Identifying Areas of Potential Use of Reclaimed Water for Environmental Benefit:**

Below are *examples* of uses of reclaimed water *that comply with State, Federal and other reclaimed water environmental, health and safety standards*. All of these uses are currently in effect somewhere in Washington State. To the best of your knowledge, are any of these potential uses for reclaimed water applicable to your area?

River Augmentation (choose one):

☐ Yes, our water rights are limited by instream flows. For more information, King County may contact:

☐ The information requested is unknown, or not available.

Additional Comments: There is adequate water supply with existing instream flow conditions being met.

Groundwater Recharge (choose one):

☐ Yes, we withdraw water from an aquifer that is in a groundwater management area, or from a declining aquifer, where water levels may need to be replenished or to maintain aquifer storage. For more information, King County may contact:

☐ The information requested is unknown, or not available.

Additional Comments: See pending water right permit application for Seattle Well Fields.

Water Rights Mitigation (choose one):

☐ Yes, our area is pursuing, or planning to pursue, new or additional water rights, and there may be an opportunity to use reclaimed water for mitigation of those new water rights. For more information, King County may contact:

☒ The information requested is unknown, or not available.

Additional Comments: _____

Potential Areas of Environmental Need (choose one):

☐ Yes, parts of our service area include potential environmental enhancement locations, such as wetlands enhancement, aquifer recharge, stream flow augmentation, that might be candidates for reclaimed water use. For more information, King County may contact:

☒ The information requested is unknown, or not available.

Additional Comments: _____

4. **Local Reclaimed Water Legislation:** If water reclamation is mandated for this water system through local government agreement, contract, local regulations, ordinances, or other mechanisms, please provide a copy of the governing mechanism (choose one).

☐ Yes, local legislation exists in our area in support of reclaimed water use. The following relevant legislation is attached (please list titles of documents):

☒ No water reclamation legislation exists, or is known to exist, at a local level in our service area.

5. **Coordination with Local Wastewater Utility:** Include a brief description of your interactions with any wastewater or reclaimed water utility (King County or other) adjacent to your service area to evaluate any potential opportunities to develop reclaimed water (choose one).

☒ Describe if applicable:

Coordination with King County occurs through ongoing participation in the MWPAAC on development of the BRET, and evaluation of potential opportunities such as described in SPU list of potential reclaimed water projects.

None. Additional Comments: "An Economic Analysis of the North Seattle Reclaimed Water Project," September 2010.

Template for

Inventory of Water Users and Identification of Potential Reclaimed Water Users

[illegible]

¹ See Washington State Reclamation and Reuse Standards, September 1997, Section 1, Articles 1-5 for allowable uses of reclaimed water. <http://www.ecy.wa.gov/PROGRAMS/WQ/reclaim/standards.html>

Seattle Public Utilities
Inventory of Water Users and Identification of Potential Water Users

Site Owner or Site Name	Site Address (for general mapping purposes)	Estimated Annual Water Use (Total 2016)	Water uses not requiring potable water ¹	Is this a Potential Reclaimed Water Customer?
PORT OF SEATTLE (SeaTac Airport)	2011 S 160TH ST	298,244 ccf	Possible landscape irrigation, fire fighting and protection, cooling water make-up, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON (Husky Stadium)	3900 MONTLAKE BLVD NE	203,341 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON (UW Animal Research and Care Facility)	1450 NE BOAT ST	183,033 ccf	Site under construction in 2016.	Unknown
CERTAINTED GYPSUM	5931-37 E MARGINAL WAY S	108,993 ccf	Possible cooling water make-up, fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
NUCOR STEEL SEATTLE	4001 28TH AVE SW	92,720 ccf	Possible industrial process, cooling water make-up, dust control, fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
PORT OF SEATTLE	2031 W HALLADAY ST	82,654 ccf	Possible cooling water make-up, ship ballast, fire fighting and protection, toilet and urinal flushing.	Unknown
DARIGOLD	4058 RAINIER AVE S	77,987 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON	2235-45 NE 45TH ST	68,601 ccf	Possible landscape irrigation, fire fighting and protection, cooling water make-up, pavement washing, toilet and urinal flushing.	Unknown
ENWAVE SEATTLE (formerly Seattle Steam Company)	1319 WESTERN AVE	61,791 ccf	Possible industrial boiler feed, fire fighting and protection, pavement washing, and toilet and urinal flushing. Also has own well and several customers re-use condensate.	Unknown
V A MEDICAL CENTER 04 SITE 663	4441 BEACON AVE S	59,568 ccf	Possible landscape irrigation, fire fighting and protection, cooling water make-up, pavement washing, toilet and urinal flushing.	Unknown
KING COUNTY FACILITIES MANAGEMENT (King County Correctional Facility - Seattle)	500 5TH AVE	53,146 ccf	Possible cooling water make-up, landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
SEATTLE SHERATON HOTEL	1400-32 6TH AVE	50,341 ccf	Possible cooling water make-up, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON (UW Consolidated Laundry)	2901 27TH AVE S	45,858 ccf	Possible cooling water make-up, fire fighting and protection, pavement washing, toilet and urinal flushing. Extensive re-use on-site for laundry.	Unknown
SEATTLE TUNNEL PARTNERS	811 1ST AVE S	45,202 ccf	Possible construction and dust control. (Short-term use to support Alaska Way Viaduct Tunnel construction.)	Unknown
SWEDISH MEDICAL CENTER	801 BROADWAY	44,401 ccf	Unknown	Unknown
UNIVERSITY OF WASHINGTON	1901 NE 45TH ST	41,865 ccf	Possible landscape irrigation, fire fighting and protection, cooling water make-up, pavement washing, toilet and urinal flushing.	Unknown
WOODLAND PARK ZOOLOGICAL SOCIETY	5500 PHINNEY AVE N	41,192 ccf	Possible landscape Irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
CALPORTLAND	5975 E MARGINAL WAY S	39,513 ccf	Possible cooling water make-up fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
SHOREWOOD HEIGHTS	3209 SHOREWOOD DR, MERCER ISLAND	35,746 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
HEDREEN LLC (Grand Hyatt Seattle)	721 PINE ST	35,572 ccf	Possible cooling water make-up, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown

SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

A. WATER RESOURCES

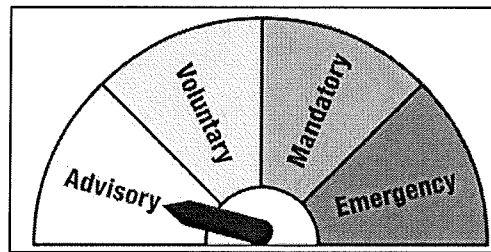
APPENDIX A-6
Water Shortage Contingency Plan

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SEATTLE PUBLIC UTILITIES

WATER SHORTAGE CONTINGENCY PLAN

March 2018



**SUPPLEMENT TO THE SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN**

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Acronym List

DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EJSE	Environmental Justice and Service Equity
GM/CEO	General Manager / Chief Executive Officer
HFAM	Hydrocomp Forecast and Analysis Model
ICS	Incident Command System
NRCS	Natural Resources Conservation Service
NOAA	National Oceanic and Atmospheric Administration
SPU	Seattle Public Utilities
SMC	Seattle Municipal Code
USGS	U.S. Geological Survey
WSAG	Water Shortage Advisory Group
WSCP	Water Shortage Contingency Plan

1.Introduction

1.1. Purpose

This Water Shortage Contingency Plan (WSCP) provides guidelines for Seattle Public Utilities (SPU) to manage water supply and demand in the event of a water shortage. The plan enables SPU to maintain essential public health and safety and minimize adverse impacts on economic activity, environmental resources and the region's water use preferences. Water shortages could result from forecasted, progressive events such as droughts, as well as immediate crises such as system failures like a major infrastructure break.

This document supplements SPU's 2019 Water System Plan, and updates SPU's 2006 Water Shortage Contingency Plan. The WSCP will be reviewed and revised as needed during the next water system plan update anticipated in 2028, or may be updated as appropriate.

1.2. Plan Organization

This plan is comprised of the following chapters:

1. **Introduction:** This chapter provides a general overview of the WSCP, including a description of the water shortage response stages and the WSCP implementation process.
2. **Implementation Considerations:** This chapter provides context for many of the elements in Chapters 3 and 4 and describes the background, details, and nuances of many aspects of the plan. The organization of this chapter largely mirrors that of Chapters 3 and 4.
3. **Implementation for a Progressive Event:** This chapter describes how the WSCP would be used in a progressive event, such as a drought, and is intended to be operational in nature. It describes what needs to be done in each water shortage response stage and assigns implementation responsibilities. A bullet format is used to aid in comprehension and navigation. For each stage, the following subjects are covered:
 - Triggers
 - Objectives
 - Stage Activation
 - Demand Reduction Goal
 - Key Public Messages
 - Coordination and Communication Actions

- Water Quality and Supply Management Actions
 - Retail Customer Demand Actions
 - Wholesale Customer Actions
4. **Implementation for an Immediate Crisis:** This chapter is similar to Chapter 3, however it focuses on implementing the WSCP when an event, such as a system failure, hinders SPU's ability to supply enough water to meet customer demands, and requires immediate action.

1.3. Overview of Water Shortage Response Stages

The WSCP has four water shortage response stages – Advisory, Voluntary, Mandatory, Emergency – which are typically implemented progressively depending on the magnitude of the water shortage. In the event of an immediate crisis, the plan may be activated at one of the more aggressive stages. Each stage contains a variety of strategies for managing aspects such as supply, utility operations, customer actions, and communications. The four stages of the WSCP are described below. The key aspects of each stage are provided in Table 1.

- **Advisory Stage** – The plan typically begins in the Advisory Stage when SPU recognizes there is a serious potential for a water shortage. At this stage, SPU implements supply management actions, as well as formal planning activities including formation of its internal Water Shortage Response Team and coordination with other City of Seattle departments, State agencies, and wholesale customers. No customer action is requested at this stage. However, customers and the media may start to inquire about the potential for a water shortage and SPU should be ready to answer questions. The authority to enter the Advisory Stage, which in most cases will activate the WSCP, lies with the SPU General Manager and Chief Executive Officer (GM/CEO).
- **Voluntary Stage** - If supply conditions worsen, the plan moves to the Voluntary Stage. This stage relies on the voluntary cooperation and support of customers to meet target reduction goals. During the Voluntary Stage, specific voluntary actions are suggested for residential and commercial customers. The suggested customer actions are a combination of standard conservation practices (e.g., avoid watering mid-day) and curtailments that require customers to reduce their water use, which may result in sacrifice (e.g., take a shorter shower). The level of that sacrifice will depend on the severity of the water shortage. The authority to enter the Voluntary Stage lies with the City of Seattle Mayor, based on the recommendation of the SPU GM/CEO.
- **Mandatory Stage** - If the Voluntary Stage does not produce needed water use reductions, or if supply conditions worsen, the Mandatory Stage would be implemented. This stage prohibits or limits certain actions, which may be accompanied by an enforcement plan, which could include fines for repeated

violation, as well as exemptions. The customer actions in this stage reflect a more aggressive approach that requires deeper levels of customer sacrifice (e.g., restricting irrigation). This stage may also include rate surcharges, although careful consideration would be required of the impacts of those charges compared to the balance in SPU's Revenue Stabilization Fund. The authority to enter the Mandatory Stage lies with the City of Seattle Mayor, based on the recommendation of the SPU GM/CEO.

- **Emergency Stage** - This stage addresses the most severe need for demand reduction and includes a combination of mandatory actions and rate surcharges. This would be the last stage used to address a progressive situation, such as a drought of increasing severity, or to respond to an immediate crisis, such as a major facility failure. The authority to enter the Emergency Stage lies with the City of Seattle Mayor, based on the recommendation of the SPU GM/CEO, unless there is an immediate emergency, in which the SPU GM/CEO may authorize these actions according to SMC 21.04.500 and 21.04.505.

1.4. Overview of Implementation Process

After determining that a serious potential for a water shortage exists, implementation of the WSCP begins with activation of the plan, which includes three steps. The first step is for the SPU GM/CEO to identify a SPU staff member to lead the water shortage response effort. The second step is to form the Water Shortage Response Team, which is a team of SPU staff whose role is to evaluate conditions, advise the GM/CEO on supply and demand actions, and make assignments to SPU staff as needed to respond to the shortage. The team should consist of representatives from a broad range of work groups that can provide insight and will be impacted including, but not necessarily limited to, supply, operations, demand management, communications, and finance. Suggested team roles to be filled are provided in Appendix A. The third step is for the GM/CEO to communicate the nature and scope of WSCP stage actions and strategies to the Mayor and the Seattle City Council (prior to activating the WSCP) and receive their input.

Once the WSCP is activated, the Water Shortage Advisory Group (WSAG) should be formed. The WSAG is a team of key customers and stakeholders whose role is to advise the Water Shortage Response Team on requests or actions made to customers regarding utility water shortage response actions and programs. The WSAG should consist of representatives from a broad range of perspectives that can provide insight and will be impacted including, but not necessarily limited to, wholesale water customers, residential customers, the landscape community, the business community, and environmental (instream) interests. Suggested membership is provided in Appendix B.

Once the WSCP is activated, a two-prong effort ensues. One prong is focused on implementing the initial stage (typically the Advisory Stage). The other prong is to begin planning for possible implementation of a subsequent stage. Typically, a minimum of two weeks is recommended before moving to a new stage, although four weeks may be more realistic to allow for carefully considered decision-making and appropriate planning time.

When considering moving from one stage to another, the decision inputs are the same as for initiating the WSCP and include consultation with the Water Shortage Advisory Group and evaluation of customer response.

A key aspect of implementing the WSCP is determining how and when to ramp down the stages and/or exit the plan. As soon as actual and forecasted supply conditions substantially improve, SPU will either inform the public of the return to normal use of water, or inform them that the utility is moving to a lesser stage of this plan. This latter process would occur until there was a return to normal operations. Stages could be skipped in this process as conditions and forecasts warrant.

Table 1 Summary of Water Shortage Contingency Plan¹

Component	Stage		
	Advisory	Voluntary	Mandatory
Hallmark	- Formal planning internally & w/ key stakeholders - Supply mgmt. actions - No customer outreach	Voluntary customer demand reductions	- Mandatory water use restrictions - Potential fines and/or rate surcharges
Trigger	Serious potential for water shortage	Supply conditions worsen	Supply conditions worsen
Objective	- Prepare for Voluntary - Stretch supply	- Achieve demand reduction - Stretch supply - Prepare for Mandatory	- Achieve demand reduction - Stretch supply
Stage Activation	SPU GM/CEO	Mayor	- Mayor, if progressive - SPU GM/CEO, if immediate
Demand Reduction Goal	- None (stage is internally focused) - Anticipate public and media inquiries and be ready to answer questions	- Determined by Water Shortage Response Team - Moving to Voluntary - Need customer assistance to meet demand reduction goal - Request suggested demand reduction actions	- Determined by Water Shortage Response Team - Moving to Mandatory - Mandatory water use restrictions & potential rate surcharge - Certain exemptions apply
Key Public Messages			- Moving to Emergency - Increased water use restrictions & potential rate surcharge

Component	Stage			
	Advisory	Voluntary	Mandatory	Emergency
Coordination & Communication	• Form Water Shortage Response Team • Form Water Shortage Advisory Group • Develop communication/outreach plan	• Implement communication/outreach plan • Implement coord. w/ key stakeholders	• Implement communication/outreach plan • Implement coord. w/ key stakeholders	• Implement communication/outreach plan • Implement coord. w/ key stakeholders
Water Quality & Supply Management	• Optimize supply • Ready emergency supplies	• Ready or activate emergency supplies, as appropriate • Investigate interties	• Activate emergency supplies and interties	• Activate emergency supplies and interties
Retail Customer Demand Actions	• None for general public (stage is internally focused) • Seattle Parks activates their WSCP	• Request voluntary demand reduction actions • Request demand reduction actions from City departments • Restrict new hydrant permits	• Provide mandatory demand reduction actions (& exemptions) • Require demand reduction actions from City departments • Rescind hydrant permits • Potential rate surcharges	• Provide mandatory demand reduction actions (& exemptions) • Require demand reduction actions from City departments • Potential rate surcharges
Wholesale Customer Actions	• Activate their WSCPs	• Move to Voluntary in their WSCPs • Outreach to their retail customers • Activate alternative sources, if appropriate	• Move to Mandatory in their WSCPs • Outreach to their retail customers, including enforcement as appropriate • Activate alternative sources, if not already done	• Move to Emergency in their WSCPs • Outreach to their retail customers, including enforcement as appropriate • Activate alternative sources, if not already done

1. This table reflects how the WSCP would be implemented for a progressive event, such as a drought. As described in Chapter 4, the stages may be different for an immediate crisis.

2. Implementation Considerations

2.1. WSCP Principles

SPU has learned a great deal over the years about how best to operate the utility during water shortage events, while minimizing impacts to customers and instream resources. This knowledge is reflected in this WSCP, and articulated in the following principles:

- **Plan Should be Flexible:** Each water shortage situation has enough unique characteristics that a plan cannot specifically define all the scenarios and specific supply and demand management actions. The usefulness of a Water Shortage Contingency Plan lies in planning the range of supply and demand management actions in advance of the situation, and in defining the communication mechanisms by which decisions will be made during the event.
- **Shortage Should Be Shared:** A key assumption of this plan is that shortage and risk must be shared among all beneficiaries of the water resource. For example, instream flow levels below normal minimums at locations specified in the Tolt and Cedar agreements are resorted to only after human water consumption is curtailed. Additionally, all water utilities obtaining water from the Seattle regional water supply system should participate in management of the shortage. Similarly, all customer sectors should participate.
- **Conservation Versus Curtailment:** Given the highly-effective long-term regional conservation program operated by SPU, it is important to distinguish between the short-term curtailment actions necessitated by a water shortage event, and the conservation actions SPU regularly promotes to its customers. Conservation focuses on long-term efficiencies which do not adversely affect customers' accustomed use of water, whereas curtailment actions involve short-term water use reductions or restrictions that can create hardships.
- **Voluntary Preferred Over Mandatory:** Customers prefer the opportunity to meet targeted demand reduction levels through voluntary compliance actions. The decision to move to mandatory restrictions is more acceptable if the voluntary approach has been tried first, but has not resulted in sufficient demand reduction.
- **Safeguard Water Quality:** It is essential to closely monitor water quality during water shortages and particularly during a warm weather drought. This applies to water quality in rivers as well as to the drinking water provided to customers. Water quality issues must be considered for drinking water and instream uses when supply management decisions are made. The SPU water distribution system is designed to carry a large capacity of water during summer peak months and for potential fire fighting. If demand is significantly lowered, coupled with warmer temperatures, water quality can significantly degrade and should be monitored and managed more carefully than typical.

2.2. Types of Drought

Droughts are the most common reason this WSCP would be implemented. Droughts are naturally occurring, unpredictable weather events of varying frequency, duration and severity. The area served by the Seattle regional water supply system has experienced several short-term droughts. Available data indicate a very low probability of a multi-year drought.

To understand the impact of drought, it is important to understand how the mountain storage reservoirs in the Seattle regional water supply system are operated. Those reservoirs operate with an annual refill and drawdown cycle. During the winter, the reservoirs are kept low to provide a “flood pocket” to reduce downstream flooding and river scour. In the spring, they are refilled by melting snow and rain. During the summer, their levels decrease because water use outstrips replenishment from rain. During the fall, their levels increase as water use decreases and fall rains return. Drought affects this cycle and can cause water shortages.

The types of droughts that affect the Seattle regional water supply system range from poor snowpack accumulation in the winter, to dry hot summers, to delayed onset of rains in the fall. Details on these three types of droughts are provided below. Since the nature of these droughts varies, SPU’s response will also vary. Examples of past drought events that resulted in SPU activating its WSCP are provided in Appendix C.

2.2.1. Winter/Spring Drought (Low Snowpack)

Droughts in the winter and spring are characterized by low snowpack. While low snowpack may not lead to poor water supply conditions if ample spring rains occur, caution is used in managing the water supply in these situations because rainfall is inherently difficult to forecast. Low snowpack can occur when mountain temperatures are warm, when precipitation is below average, when intense rainfall events melt low to mid-elevation snow, or through a combination of these factors.

SPU attempts to manage for these types of droughts in several ways. Tracking El Niño events, which are typified in the Pacific Northwest by warmer and drier than average winter conditions, can alert water managers to the increased potential of a winter/spring drought. SPU’s use of the dynamic rule curve – varying reservoir storage targets based on real-time snowpack measurements and soil moisture estimates – in these types of droughts helps to ensure that our reservoirs are as close to full as possible at the start of the summer drawdown cycle.

When winter/spring drought conditions result in low water supply availability, implementation of the WSCP may be necessary because the potential for water use reductions by customers is greater in the spring and summer, there is much uncertainty about impending summer weather which is so influential on demand, and weather forecasts of when the fall rains will begin are not reliable. These conditions generate

uncertainty about whether water stored in the spring will be sufficient to meet demands until supplies are replenished in the fall. This can make implementation of the WSCP in the spring and summer necessary, despite the fact that in some of these years no water shortfall actually develops.

2.2.2. Summer/Fall Drought (Hot, Dry Temperatures)

Droughts in the summer and fall are characterized by drier conditions and hotter temperatures. This typically results in both decreased supply and increased demand. Supply is decreased because less rain results in less inflow into the reservoirs. Demand is increased because outdoor water use (mostly irrigation) is higher at this time of year.

SPU attempts to manage for these types of droughts by carefully monitoring summer demands and water supply. Unfortunately, it is not possible to accurately predict in advance the timing and amount of the fall rains. A key management tool for this type of drought is helping customers to reduce irrigation use.

2.2.3. Fall/Early Winter Drought (Delayed Fall Rains)

Droughts in the fall and early winter are characterized by the fall rainy season developing later than normal. This can result in storage reservoirs being depleted to minimum levels.

Fall droughts are particularly challenging because that is when water demands for fish habitat needs are especially high and when the ability for people to reduce water use is limited since the irrigation season is ending.

SPU attempts to manage for these types of droughts using a number of water supply tools, including using emergency pumping plants at Chester Morse Lake to access water stored in the lake that cannot flow out by gravity.

2.3. Trigger Considerations

SPU continuously monitors water supply conditions to meet the operational objectives of providing water for municipal use, instream aquatic habitat (fisheries), flood management, and hydropower production. To deal with hydrologic uncertainty in real-time and in longer term planning horizons, SPU uses a number of informational and data gathering sources and forecasting tools.

SPU contracts with the U.S. Geological Survey (USGS) to provide continuous streamflow monitoring and data collection services. Strategic placement of USGS stream gauging stations provides real-time information for understanding the hydrologic state of the water supply and river systems. SPU also contracts with the Natural Resources Conservation Service (NRCS) to provide real-time snow monitoring and weather data collection services.

Through the National Oceanic and Atmospheric Administration (NOAA), SPU regularly monitors daily weather forecasts (National Weather Service Seattle Forecasting Office), mid-range weather forecasts (National Centers for Environmental Prediction), 30- and 90-day and multi-season climate outlooks (Climate Prediction Center), and daily hydrometeorological forecasts (Northwest River Forecast Center in Portland, Oregon). The internet provides access to vast amounts of additional useful information to assist SPU in forecasting. For example, NOAA's web information on El Niño/La Niña provides a wealth of timely information on current and forecasted El Niño and La Niña conditions with enough lead time for water resource managers to prepare for such events.

SPU also uses an in-house reservoir management and streamflow forecasts computer model known as the Hydrocomp Forecast and Analysis Model (HFAM). The HFAM model is regularly updated with hourly meteorological and hydrological data, and simulates the current state of the watershed (including snowpack, soil moisture, aquifer storage, and streamflows) and water supply system. The model is used to analyze and assess various future reservoir operating scenarios, both in real time and in near- and long-term operational planning, based on probabilistic analysis of nearly 90 years of historic weather.

SPU intensifies ongoing monitoring of water supply conditions during potential water shortage. This information is used to determine when to activate the WSCP and when to move between stages. The following factors may be considered in these decisions:

- Total supply availability, including groundwater, interties, and modified instream flow releases
- Rate of decline in total reservoir storage compared with typical rates
- Short- and long-term weather and hydrologic forecasts
- Computer modeling of streamflow and reservoir storage, for different weather and demand assumptions
- Trends and forecasts of the system's daily water demands
- Demand reduction goals
- Estimated margin of safety provided by the demand reduction, compared with the level of risk assumed if no action is taken
- Recommendations from the Cedar River Instream Flow Commission and the Tolt Fisheries Advisory Committee
- Increased operating costs of potential actions and the value of lost water sales revenue, compared with the increased margin of reliability

2.4. Goal Setting Considerations

Providing a demand reduction goal signals to the public the severity of the situation and provides a metric for which to measure success. The demand reduction goal should be set

so that it can reasonably be achieved with the demand reductions actions requested or required. Because the level of demand reductions and actions will vary for each event, the WSCP does not prescribe a metric or reduction level. Metrics and goals used in past water shortage events can be considered for future events. Factors to consider in selecting a metric and goal are:

- **Measurable:** Data need to be readily available to report out in a timely fashion on achievement towards the goal.
- **Understandable:** The metric and goal should be easy to explain to customers and the media, and performance should be easy to communicate via simple graphics. Customers should be able to understand how their actions will help achieve the goal.
- **Meaningful:** The goal should be set at a level matching the severity of the event, especially to demonstrate significant customer participation prior to any lowering of instream flows to below normal minimum.
- **Reasonableness:** The goal should reflect the reduction potential associated with the demand reduction actions and time of year. If there are key uncertainties, consider using a range instead of an absolute number.
- **Scalable:** If conditions worsen to the next stage, then the goal should be changed to reflect the need for greater demand reductions, given the time of year.
- **Consistency:** As appropriate, use a metric and goals that are consistent with neighboring utilities.

2.5. Coordination and Communication Considerations

2.5.1. Relationship to Wholesale Customers' WSCPs

There are more than 1.4 million people living in the areas served by SPU and our wholesale water customers. SPU provides water to utilities in much of King County and a small part of Snohomish County. SPU has contracts with 18 wholesale customers, plus the Cascade Water Alliance which wholesales water to five cities and two water districts in the region. Additionally, the City of North Bend receives mitigation water from SPU. Water shortages affect SPU's retail customers as well as SPU's wholesale customers and their respective retail customers.

SPU's water wholesale contracts include a provision that wholesale customers will assist and support actions required to manage demand during a shortage or an emergency. When SPU activates its WSCP, it will request that each wholesale customer also activate their WSCP. This plan has been developed by SPU, in consultation with its wholesale customers and other participants, based on the premise that an effective demand management strategy must be regionally consistent. This is based on several considerations:

- **Shortage Should Be Shared:** Shortage and risk must be shared among all beneficiaries of the water resource, including all water utilities obtaining water from the Seattle regional water supply system.
- **Unified Message:** A unified/regional message and approach is easier to understand and distribute through the media, which is key in communicating information to the public.
- **Consistency Aids Forecasting:** Consistency makes it easier for SPU to forecast demand reductions, which is essential to effectively manage the system during a water shortage.

2.5.2. Coordination With Key Resource Management Agencies

The Washington State Department of Ecology has authority regarding statewide drought declaration. Early and consistent communication with Ecology, which advises the Governor's Office, is important to ensure that the actions and public messages take into account conditions of the Seattle regional water supply system. SPU should participate in the meetings of the State's Water Supply Advisory Committee to better understand state-wide drought conditions, coordinate on messages, and provide input on the status of the Seattle regional water supply system.

SPU's Water Resources Management staff also works closely with members of other city, local, state, federal and tribal resource agencies, including Seattle City Light, King County, Washington State Department of Fish and Wildlife, Washington State Department of Ecology, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, National Marine Fisheries Services, Muckleshoot Indian Tribe, and Tulalip Tribes. This coordination typically occurs at the Cedar River Instream Flow Commission and the Tolt Fisheries Advisory Committee.

2.5.3. Coordination with Neighboring Jurisdictions

SPU will communicate and coordinate with neighboring jurisdictions – especially Tacoma and Everett – to ensure, to the extent practical, that the timing of plan activation and requests to customers are linked when appropriate and provide opportunities for regional messaging.

2.6. Water Quality and Supply Management Considerations

2.6.1. Managing Instream Flows

The management of stream flows downstream of SPU's water storage and diversion facilities is a critical consideration in managing water resources during water shortages. In addition to meeting the needs of SPU's retail and wholesale customers, the Cedar and South Fork Tolt rivers are managed to protect instream resources.

SPU has ongoing formal and informal agreements with state, federal and local resource agencies, Indian Tribes and the U.S. Army Corps of Engineers that help guide how it manages streamflows. Streamflow management in the South Fork Tolt is governed by the South Fork Tolt River Settlement Agreement. Cedar River flows are governed by the Cedar River Instream Flow Agreement, a component of the Cedar River Watershed Habitat Conservation Plan (HCP). These agreements provide guaranteed flow regimes, as well as adaptive features to ensure that water is released from SPU's storage reservoirs in a manner that provides beneficial conditions for salmon and other species downstream of the reservoirs. The protective provisions of the governing agreements are particularly important during droughts and associated periods of low stream flow.

Additionally, salmon and steelhead redd surveys are undertaken during seasonal fish spawning events that enable informed management decisions to be made that seek to ensure adequate flow levels are provided during fish incubation and emergence periods.

The Cedar River also provides approximately half of the inflow to Lake Washington on an annual average basis. The U.S. Army Corps of Engineers manages Lake Washington lake levels as part of its Lake Washington Ship Canal Project (Hiram Chittenden Locks in Ballard) which connects Lake Washington to the saltwater of Puget Sound. Their management objectives include providing water flows at the Locks for navigation, fish passage, and control of the salt water intrusion caused by operation of the Locks.

2.6.2. Reservoir Management

Operational flexibility of SPU's mountain reservoirs is key, with operating plans changing as conditions and forecasts change. SPU has developed "dynamic rule curves" to operate its mountain reservoirs in the winter season. The dynamic rule curves are used to adjust operations to actual watershed conditions and to help manage risk and uncertainty. These rules set target reservoir surface water levels that vary with watershed snowpack and soil moisture conditions. At times when there is little snowpack and low soil moisture, the reservoir surface water level target will be set higher than normal flood management levels, and vice versa.

2.6.3. Alternative Water Supplies

Depending on the nature and timing of a water shortage, alternative or emergency water supplies may be useful to supplement existing supplies. SPU has several options available:

- **Chester Morse Extra Storage:** SPU's primary storage reservoir has a natural, gravity fed outlet. When the reservoir is low, its water surface elevation can fall below the natural outlet, but still contain a substantial amount of high-quality water. As of 2016, a new Morse Lake Pump Plant was installed to replace two existing floating pump plants, and one of the existing floating pump plants was refurbished as a backup plant. These plants can be used to pump the lower elevation water over

the natural outlet and into the river, thereby augmenting both instream flows and water availability for customer use.

- **Interties:** Since water supply problems may not affect all water suppliers in the region to the same extent, it is sometimes feasible for SPU and its wholesale customers to obtain water from other providers through interties.
- **Reclaimed Water:** Reclaimed water is highly-treated effluent that may be used instead of potable water for irrigation, street washing, construction purposes, etc., in order to reduce demand for potable water and lessen the impact of shortages on the community. Since 2013, King County's Brightwater Treatment Plant has been providing Class A reclaimed water for off-site irrigation, street cleaning, and sewer flushing.

2.7. Demand Reduction Considerations

2.7.1. Demand Reduction Actions

A key strategy to managing a water shortage event is having customers reduce their water use. The WSCP does not pre-identify specific demand reduction actions for each stage. Rather a comprehensive list of potential actions customers can take to reduce water use is provided in Appendix E. The actual actions requested or required for each stage will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed.

There are several criteria for deciding which demand reduction actions are appropriate during a water shortage:

- **Magnitude of Savings:** Will the action result in enough savings to make a meaningful difference?
- **Timing:** Can the action produce results in the necessary timeframe?
- **Duration of Event:** What is the anticipated duration of the event (e.g., customers may tolerate certain mandatory curtailments if the event is expected to last a few weeks rather than months)?
- **Season:** Is the action relevant to the time of year (e.g., banning lawn watering during summer irrigation season vs. during non-irrigation season)?
- **Costs:** How severe are the cost implications of the action to the customer relative to the need for action?
- **Enforcement:** For mandatory curtailment actions, is it desirable and practical to enforce the action?
- **Equity:** Do the suite of actions cover all customer sectors and types of uses?

2.7.2. Exemptions

Appendix G provides background and a framework for developing and implementing exemptions to customer water use restrictions that are part of the Mandatory and Emergency stages of the WSCP.

2.8. Financial Considerations

Reducing water demand as needed to address a water shortage event can reduce revenues at a time when there is an increased need for these funds to cover costs associated with implementing the WSCP. This can be exacerbated by other factors such as reductions in block contract allocations. Accordingly, the following issues should be considered.

- **Reprioritize Current Revenue:** This consists of reducing revenue contributions to the capital program and lowering the year end operating cash target. These are the most flexible resources to offset revenue and expenditure problems.
- **Reprioritize Expenses:** Reducing planned operations and maintenance expenditures can ease the demand on revenues or free up money to meet unexpected needs.
- **Revenue Stabilization Subfund:** The City of Seattle has established a Revenue Stabilization Subfund for the water fund. The target balance is \$9 million, which can serve as a source of revenue during moderate droughts. Withdrawals from the Subfund require City Council approval.
- **Rate Surcharge:** In the mandatory and emergency stage, rate surcharges can be used to send a strong signal to customers to reduce water use. Rate surcharges can also help to make-up revenues lost due to decreased demand.
- **Block Contract Credits:** The block wholesale water contracts that SPU has with Northshore Utility District and Cascade Water Alliance have provisions that reduce their block allocations in proportion with all other wholesale customers, thereby reducing their required payments to SPU.
- **State Drought Relief Funds:** In a Washington State emergency drought declaration, funds in the form of grants or loans may be available to SPU to mitigate the impacts of a water shortage.

3. Implementation for a Progressive Event

For each stage, the following information is provided. Note that if a particular stage is not entered into progressively, actions listed in the previous stage(s) may be appropriate as well.

1. **Triggers** – Describes the general, qualitative conditions that would trigger the stage. Note there are no pre-determined, quantitative conditions that trigger stages.
2. **Objectives** – Describes the overall objective of the stage.
3. **Stage Activation** – Describes who has the authority to enter the stage (either the SPU GM/CEO or the Mayor).
4. **Demand Reduction Goal** – Discusses the general, qualitative nature of the goal for the stage. Note there are no pre-determined, quantitative demand reduction goals for each stage.
5. **Key Public Messages** – Describes the key public messages for the stage. The messaging work is led by the Communications Lead.
6. **Coordination and Communication Actions** – Describes a variety of work necessary to coordinate and communicate with key stakeholders such as WSAG, wholesale customers, Ecology, Department of Health, natural resource agencies, tribes, City employees, the general public, etc. The overall work is led by the Water Shortage Response Team Lead, who makes assignments as appropriate.
7. **Water Quality and Supply Management Actions** – Describes work necessary to safeguard water quality and to maximize supply. This work is led by the Supply Management Lead.
8. **Retail Customer Demand Actions** – Describes work necessary to reduce customer demand. This work is led by the Demand Management Lead.
9. **Wholesale Customer Actions** - Describes actions required by each wholesale customer. Communication and monitoring of these actions is done by the Wholesale Customers Lead.

3.1. Advisory Stage

3.1.1. Triggers

- Supply conditions and supply forecasts raise significant concerns about the utility's ability to meet demand later in the year.

3.1.2. Objectives

- Prepare the Department, City, and relevant agencies for a potential water shortage thereby allowing all parties adequate planning and coordination time in the event there is a need to move to the Voluntary Stage.
- Stretch available supply through supply management actions.

3.1.3. Stage Activation

- The authority to enter the Advisory Stage, which in most cases is effectively activating the WSCP, lies with the SPU GM/CEO.

3.1.4. Demand Reduction Goal

- None, as described earlier, the Advisory Stage is an internally focused stage that does not include outreach to customers.

3.1.5. Key Public Messages

Although the Advisory Stage is not intended to be a public stage, SPU should be prepared to answer inquiries from the public and media as follows:

- **Planning:** Due to the potential for a water shortage, SPU has entered the planning phase of the WSCP to coordinate actions in the event we need to move to the Voluntary Stage.
- **Supply Conditions:** Report on supply conditions and forecasts.
- **No Customer Action:** At this time, customers are not being asked to take special action. (If pressed: SPU has an ongoing conservation program and always encourages customers to use water wisely. See www.savingwater.org for ways to use water wisely, indoors as well as outdoors during the summer irrigation season.)
- **Future Customer Action May Be Needed:** Customers may be asked to reduce their water use if conditions worsen and we move to the next stage (Voluntary Stage).

3.1.6. Coordination and Communication Actions

- **Water Shortage Response Lead & Team:** Identify the lead and team members for the Water Shortage Response Team. Consider using an Incident Command System to organize the response.
- **Wholesale Customers:** Inform wholesale customers about current water supply conditions, that the Advisory Stage has been triggered, and that planning is underway in the event that elevation to the Voluntary Stage is needed. Request their cooperation, as identified under the Wholesale Customer Actions section. Request a wholesale customer representative for the WSAG.
- **WSAG:** Form the Water Shortage Advisory Group (WSAG), as described earlier. Early meetings will focus on explaining the role of WSAG and educating the WSAG about the water system, particularly the relationship of weather patterns to supply and demand, and the customer base. For this stage, the role of the WSAG is to provide input on WSAG membership, potential customer demand reduction strategies, and on outreach strategy and materials.
- **Ecology:** Participate on Ecology's Water Supply Advisory Committee to keep informed about the State drought response and to provide Ecology with updates on forecasts for the Seattle regional water supply system.
- **DOH:** Update the DOH on the shortage response and the likelihood of moving to the Voluntary Stage.
- **Public Agencies:** Coordinate with other City departments and public agencies (e.g., county, state and federal resource agencies, tribes, and other regional water suppliers, including Cascade Water Alliance and the Cities of Everett and Tacoma) about water supply conditions, projections, and potential actions.
- **Outreach:** Develop the initial communication and outreach plan, focusing primarily on the Voluntary Stage. As described in the Communication and Outreach Framework in Appendix D, the plan should include the overall purpose, goals, audiences, and tools (e.g., FAQs, press releases, tips flyers).

3.1.7. Water Quality and Supply Management Actions

- **Data Collection:** Increase data collection actions (e.g., streamflows, snowpack conditions) and monitoring weather forecasts.
- **Modeling:** Increase SPU's computer modeling runs of projected supply, storage, demand and revenue scenarios.
- **Water Quality:** Assess water quality in reservoirs and in the distribution system to identify areas that may experience degradation with reduced consumption. Increase monitoring if appropriate. Additionally, assess current water main flushing and reservoir cleaning activities to determine whether they should be

accelerated to be completed prior to the peak season or reduced to conserve supply.

- **Instream Flows:** In coordination with state and federal resource agencies and tribes, review supply and fisheries conditions to determine appropriate instream flow levels, including whether to provide supplemental flows or reduce to flows below normal minimum. (See Cedar Instream Flow agreement and Tolt settlement agreement.)
- **Optimize Supplies:** Identify and implement supply side management techniques to optimize existing sources (e.g., reducing Masonry Pool seepage, Tolt/Cedar split, etc.).
- **Emergency Supplies:** Ready emergency supplies, such as the wellfields and Morse Lake Pump Plants, for use and activate if appropriate.

3.1.8. Retail Customer Demand Actions

- **General Customer Actions:**
 - No demand reduction actions will be requested of general customers for the Advisory Stage. Some proactive outreach to customers may occur reminding them to use water wisely.
 - Determine the list of customer demand reduction actions that would be requested if the WSCP advances to the Voluntary Stage. A list of potential actions customers can take to reduce water use is provided in Appendix E. The actual actions selected for use in the Voluntary Stage will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed.
- **City Departments:** Request that the Parks and Recreation Department activate their Water Shortage Response Plan.

3.1.9. Wholesale Customer Actions

- **Activate Plans:** Activate their own WSCPs, in a manner consistent with SPU.
- **Plan for Voluntary:** Work with SPU to plan for the potential to move to the Voluntary Stage. Additionally, plan for their internal process needed to enter the Voluntary Stage.
- **Alternative Sources:** Determine feasibility of activating independent or emergency supply sources, as appropriate.
- **Flushing:** Assess current water main flushing and reservoir cleaning activities to determine whether they should be accelerated to be completed prior to the peak season or reduced to conserve supply.

3.2. Voluntary Stage

3.2.1. Triggers

- The Voluntary Stage will be implemented when: 1) supply conditions have not improved or have worsened, and/or 2) demand levels need to be reduced.

3.2.2. Objectives

- Achieve the demand reduction goals by voluntary customer action, as well as by utility actions.
- Stretch available supply through supply management actions.
- Prepare for potentially moving to the Mandatory Stage.

3.2.3. Stage Activation

- The authority to enter the Voluntary Stage lies with the Mayor, based on the recommendation of the SPU GM/CEO. This is the case whether entering the Voluntary Stage is done as the initial activation of the WSCP or as a progressive step if the WSCP is activated at a lower stage.

3.2.4. Demand Reduction Goal

- Set demand reduction goal based on supply conditions and demand reduction potential and, if appropriate, consistent with neighboring utilities. The metric for the goal will be determined by the Water Shortage Response Team.

3.2.5. Key Public Messages

- **Moving to Voluntary:** We are moving to the second stage of our WSCP, the Voluntary Stage, because our supply conditions have worsened.
- **Meet Demand Reduction Goal:** We are asking customers to voluntarily reduce their water use to meet the demand reduction goal.
- **Customers Choose Methods:** How customers achieve that reduction is up to them. A full list of options is on our website www.savingwater.org.
- **Top Suggestions:** Top suggestions include the following: *(to be determined in the previous stage; e.g., let your lawn go dormant and limit plant watering to twice a week, assuming shortage is during irrigation season).*
- **Cooperation Lessens Possibility of Mandatory Restrictions:** If everyone cooperates, we may avoid moving to the Mandatory Stage where specific water use restrictions are mandated.

3.2.6. Coordination and Communication Actions

- **Wholesale Customers:** Update wholesale customers about current water supply conditions and that the Voluntary Stage has been formally triggered. Note that in the Advisory Stage, wholesale customers would have been involved in planning for the potential of moving to the Voluntary Stage. SPU will give wholesale customers advanced notice of the intent to formally move to the Voluntary Stage, so wholesale customers can do final preparations (e.g., get their website ready). The advanced notice will likely be short in order to reduce the risk of unintended leaks to the press, which would complicate the process. Request continued cooperation, as identified under the Wholesale Customer Actions section.
- **WSAG:** SPU will provide updates on the water supply status and customer demand. For this stage, the role of the WSAG is to provide input on implementation of customer demand reduction aspects of the Voluntary Stage, as well as input on planning for the customer demand reduction aspects of the Mandatory Stage.
- **Ecology:** Continue participation on Ecology's Water Supply Advisory Committee to keep informed about the State drought response and to provide Ecology with updates on forecasts for the Seattle regional water supply system. Petition the State to include the Seattle regional water supply system service area in a State declaration of drought, if not already included.
- **DOH:** Update the DOH on the shortage response and the likelihood of moving to the Mandatory Stage.
- **Public Agencies:** Continue and intensify coordination with other City departments and public agencies (e.g., state and federal resource agencies, tribes, and other regional water suppliers, including Cascade Water Alliance and the Cities of Everett and Tacoma) about water supply conditions, projections, and potential actions.
- **Outreach:** Implement the communication and outreach plan elements developed for the Voluntary Stage. Also, develop the elements (including any exemptions and enforcement) for the Mandatory Stage. See the Communication and Outreach Framework in Appendix D.
- **SPU Employees:** Establish a regular communication mechanism to keep Department employees up to date on goals, conditions, and actions.
- **Customer Inquiries:** Establish a systematic way to respond to and track customer inquiries in a timely way. Note that customer inquiries could show up in various ways, including social media, which may require a different strategic communication approach.

- **Revenue:** Assess revenue implications and potential remedies, including reprioritizing expenses and potential withdrawals from the revenue stabilization fund.
- **Block Contracts:** Initiate block contract credit process.
- **City Legislation:** Request Council to adopt legislation on water use restrictions, enforcement and any surcharges, if anticipate needing for the Mandatory Stage and not already in place.

3.2.7. Water Quality and Supply Management Actions

- **Data Collection:** Continue increased data collection actions (e.g., streamflows, snowpack conditions) and monitoring weather forecasts.
- **Modeling:** Continue increased SPU's computer modeling runs of projected supply, storage, demand and revenue scenarios.
- **Instream Flows:** Continue coordination with state and federal resource agencies and tribes, to review supply and fisheries conditions to determine appropriate instream flow levels, including whether to provide supplemental flows or flows below normal minimum. (See Cedar Instream Flow agreement and Tolt settlement agreement.)
- **Flushing:** If necessary, implement flushing to maintain water quality. Include flushing information in public communication and outreach so the public understands it is essential for drinking water quality.
- **Emergency Supplies:** Ready emergency supplies, such as the wellfields and Morse Lake Pump Plants, for use and activate if appropriate.
- **Interties:** Investigate using existing interties to increase supply availability and activate if appropriate.

3.2.8. Retail Customer Demand Actions

- **General Customer Actions:**
 - Implement the Voluntary Stage customer demand reduction actions (that were determined in the Advisory Stage).
 - Determine the list of customer demand reduction actions that would be requested if the WSCP advances to the Mandatory Stage. A list of potential actions customers can take to reduce water use is provided in Appendix E. The actual actions selected for the Mandatory Stage will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed. Additionally, establish appropriate exemptions for the Mandatory Stage. Appendix G includes possible exemptions to water use restrictions for SPU to consider in creating

actual exemptions at the time of the event. Finally, determine appropriate enforcement strategies.

- **City Departments:** Request that City departments reduce their water use. The specific actions requested for this stage will be determined during implementation of the WSCP, however likely actions include the following:
 - **All Departments:**
 - Let lawns go dormant and limit plant watering to twice a week. Avoid mid-day watering. Post explanatory signage if these recommendations cannot be implemented. (Certain exemptions will apply.)
 - Wash fleet vehicles only if using facilities that recycle the water
 - Do not wash plazas, foyers, sidewalks, etc. with a hose. Use a broom instead. (Certain exemptions will apply where necessary for health and safety.)
 - Any applicable actions requested of general retail customers
 - **Finance and Administrative Services:**
 - Turn off decorative fountains
 - Post signage throughout buildings to encourage City employees (and the public where applicable) to reduce their water use.
 - **SPU:**
 - Suspend meter testing
 - Accelerate schedule to fix distribution system leaks
 - **Parks:** Move to the Voluntary Stage of their WSCP and implement the associated demand reduction actions
 - **Transportation:** Suspend street washing
 - **Fire Department:** Limit training exercises that use water
- **Hydrant Permits:** Restrict new hydrant permits for temporary water service to essential purposes.

3.2.9. Wholesale Customer Actions

- **Move to Next Stage:** Implement the Voluntary Stage of their WSCPs, in a manner consistent with SPU.
- **Plan for Mandatory:** Work with SPU to plan for the potential to move to the Mandatory Stage. Additionally, plan for their internal process needed to enter the Mandatory Stage.
- **Outreach to Retail Customers:** Outreach to their retail customers, as documented in Appendix F.

- **Flushing:** Assess current water main flushing and reservoir cleaning activities to determine whether they should be accelerated to be completed prior to the peak season or reduced to conserve supply.
- **Alternative Sources:** Activate alternative supply sources, if appropriate.

3.3. Mandatory Stage

3.3.1. Triggers

- The Mandatory Stage will be implemented when: 1) supply conditions have not improved, or have worsened, and/or 2) demand levels need to be further reduced.

3.3.2. Objectives

- Achieve the demand reduction goals by restricting specific water uses.
- Further stretch available supply through additional supply management actions.
- Prepare for potentially moving to the Emergency Stage.

3.3.3. Stage Activation

- The authority to enter the Mandatory Stage lies with the Mayor, based on the recommendation of the SPU GM/CEO. This is the case whether entering the Mandatory Stage is done at the initial activation of the WSCP or as a progressive step if the WSCP is activated at a lower stage.

3.3.4. Demand Reduction Goal

- Set demand reduction goal based on supply conditions and demand reduction potential consistent with water use restrictions and, if appropriate, adjust with neighboring utilities. The metric for the goal will be determined by the Water Shortage Response Team.

3.3.5. Key Public Messages

- **Moving to Mandatory:** We are moving to the third stage of our WSCP, the Mandatory Stage, because our supply situation has worsened and/or the voluntary approach in the previous stage has not resulted in the necessary demand reduction.
- **Mandatory Water Restrictions:** It is necessary to impose mandatory restrictions on certain water uses. Those restrictions are as follows: *(to be determined in the previous stage)*. There are exemptions for the following: *(to be determined in the previous stage)*.
- **Rate Surcharge:** If applicable, the rate surcharge is as follows: *(to be determined in the previous stage)*.

3.3.6. Coordination and Communication Actions

- **Wholesale Customers:** Update wholesale customers about current water supply conditions and that the Mandatory Stage has been formally triggered. Note that in the Voluntary Stage, wholesale customers would have been involved in planning for the potential of moving to the Mandatory Stage. SPU will give wholesale customers advanced notice of the intent to formally move to the Mandatory Stage, so wholesale customers can do final preparations (e.g., get their website ready). The advanced notice will likely be short in order to reduce the risk of unintended leaks to the press, which would complicate the process. Request continued cooperation, as identified under the Wholesale Customer Actions section.
- **WSAG:** SPU will provide updates on the water supply status and customer demand. For this stage, the role of the WSAG is to provide input on implementation of customer demand reduction aspects of the Mandatory Stage, as well as provide input on planning for the customer demand reduction aspects for the Emergency Stage, if likely needed.
- **Outreach:** Implement the communication and outreach plan elements developed for the Mandatory Stage. Also, develop the elements for the Emergency Stage, if likely needed. See the Communication and Outreach Framework in Appendix D.
- **Ecology:** Continue participation on Ecology's Water Supply Advisory Committee to keep informed about the State drought response and to provide Ecology with updates on forecasts for the Seattle regional water supply system.
- **DOH:** Update the DOH on the shortage response and the likelihood of moving to the Emergency Stage.
- **Public Agencies:** Continue and intensify coordination with other City departments and public agencies (e.g., state and federal resource agencies, tribes, and other regional water suppliers, including Cascade Water Alliance and the Cities of Everett and Tacoma) about water supply conditions, projections, and potential actions.
- **SPU Employees:** Continue regular communication with Department employees to keep them up to date on goals, conditions, and actions.
- **Customer Inquiries:** Continue responding to customer inquiries, using the strategy established in the Voluntary Stage. Note that customer inquiries could show up in various ways, including social media, which may require a different strategic communication approach.
- **Revenue:** Continue assessing revenue implications and potential remedies, including reprioritizing expenses and potential withdrawals from the revenue stabilization fund.
- **Block Contracts:** Ensure block contract credits are initiated.

- **City Legislation:** Request Council to adopt legislation on water use restrictions, enforcement and any surcharges, if anticipate needing for the Emergency Stage and not already in place.

3.3.7. Water Quality and Supply Management Actions

- **Data Collection:** Continue increased data collection actions (e.g., streamflows, snowpack conditions) and monitoring weather forecasts.
- **Modeling:** Continue increased SPU's computer modeling runs of projected supply, storage, demand and revenue scenarios.
- **Instream Flows:** Continue coordination with state and federal resource agencies and tribes, to review supply and fisheries conditions to determine appropriate instream flow levels. (See Cedar Instream Flow agreement and Tolt settlement agreement.)
- **Emergency Supplies:** Activate emergency supplies, such as the wellfields and Morse Lake Pump Plants, as appropriate.
- **Interties:** Activate interties, if not already implemented.
- **Reclaimed Water:** Promote reclaimed water availability to tanker trucks for street cleaning, construction projects, landscape irrigation, dust control, etc.

3.3.8. Retail Customer Demand Actions

- **General Customer Actions:**
 - Implement the Mandatory Stage customer demand reduction actions (that were determined in the Voluntary Stage).
 - Determine the list of customer demand reduction actions that would be requested if the WSCP advances to the Emergency Stage. A list of potential actions customers can take to reduce water use is provided in Appendix E. The actual actions selected for the Emergency Stage will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed.
- **City Departments:** Require that City departments reduce their water use. The specific actions requested for this stage will be determined during implementation of the WSCP, however likely actions include the following (if not already implemented under the Voluntary Stage):
 - **All Departments:**
 - Let lawns go dormant and limit plant watering to twice a week. Avoid mid-day watering. Post explanatory signage if these recommendations cannot be implemented. (Certain exemptions will apply.)

- Wash fleet vehicles only if using facilities that recycle the water
- Do not wash plazas, foyers, sidewalks, etc. with a hose. Use a broom instead. (Certain exemptions will apply where necessary for health and safety.)
- Any applicable actions required of general retail customers
- **Finance and Administrative Services:**
 - Turn off decorative fountains
 - Post signage throughout buildings to encourage City employees (and the public where applicable) to reduce their water use.
- **SPU:**
 - Suspend meter testing
 - Accelerate schedule to fix distribution system leaks
- **Parks:** Move to the Mandatory Stage of their WSCP and implement the associated demand reduction actions
- **Transportation:** Suspend street washing
- **Fire Department:** Limit training exercises that use water
- **Hydrant Permits:** Rescind hydrant permits for temporary water service, unless necessary for public health.
- **Exemptions from Water Use Restrictions:** Implement the exemptions for the Mandatory Stage water use restrictions. Determine appropriate exemptions for the Emergency Stage water use restrictions. Appendix G includes possible exemptions to water use restrictions for SPU to consider in creating actual exemptions at the time of the event.
- **Rate Surcharges:** Consider implementing rate surcharges to accelerate customer compliance with the restrictions and/or recover lost revenue.

3.3.9. Wholesale Customer Actions

- **Move to Next Stage:** Implement the Mandatory Stage of their WSCPs, in a manner consistent with SPU.
- **Plan for Emergency:** Work with SPU to plan for the potential to move to the Emergency Stage. Additionally, plan for their internal process needed to enter the Emergency Stage.
- **Outreach to Retail Customers:** Outreach to their retail customers, as documented in Appendix F.
- **Enforcement:** Enforce water use restrictions within their own service areas.

- **Flushing:** Assess current water main flushing and reservoir cleaning activities to determine whether they should be accelerated to be completed prior to the peak season or reduced to conserve supply.
- **Alternative Sources:** Activate alternative supply sources, if appropriate.

3.4. Emergency Stage

At this stage, SPU recognizes that a critical water situation exists and that, without additional significant curtailment actions, a shortage of water for public health and safety is imminent. This type of situation has never occurred in the SPU water system's history.

This stage is characterized by two basic approaches. First, increasingly stringent water use restrictions are established. Secondly, significant rate surcharges are used to increase customer compliance. A surcharge is a key component to the success of this stage.

3.4.1. Triggers

- The Emergency Stage will be implemented when: 1) supply conditions have worsened, 2) demand levels need to be further reduced, and/or 3) the prospects of a water shortage are imminent if immediate action is not taken.

3.4.2. Objectives

- Achieve the demand reduction goals by additional restrictions on water use, recognizing that for this stage customers' lives and businesses may be significantly impacted.
- Stretch available supply through supply management actions.

3.4.3. Stage Activation

- The authority to enter the Emergency Stage lies with the Mayor, based on the recommendation of the SPU GM/CEO, unless there is an immediate emergency, in which the SPU GM/CEO has the authority to enter this stage according to SMC 21.04.500 and 21.04.505.

3.4.4. Demand Reduction Goal

- Set demand reduction goal based on supply conditions and demand reduction potential consistent with water use restrictions and, if appropriate, adjust with neighboring utilities. The metric for the goal will be determined by the Water Shortage Response Team.

3.4.5. Key Public Messages

- **Moving to Emergency:** We are moving to the fourth (and final) stage of our WSCP, the Emergency Stage, because our supply situation has worsened and/or the approach in the previous stage has not resulted in the necessary demand reduction.

- **Additional Water Restrictions:** There are additional water restrictions as follows: *(to be determined in the previous stage)*. There are exemptions for the following: *(to be determined in the previous stage)*.
- **Rate Surcharge:** If applicable, the rate surcharge is as follows: *(to be determined in the previous stage)*.
- **Taste & Odor:** If applicable, taste and odor water quality problems may occur with system-wide reduced water consumption.
- **Pressure Reduction:** If applicable, pressure reduction problems may occur with system-wide reduced water consumption.

3.4.6. Coordination and Communication Actions

- **Formal Declaration of Emergency:** SPU GM/CEO declares a water supply emergency including instituting formal procedures for declaration.
- **Wholesale Customers:** Update wholesale customers about current water supply conditions and that the Emergency Stage has been formally triggered. Note that in the Mandatory Stage, wholesale customers would have been involved in planning for the potential of moving to the Emergency Stage. SPU will give wholesale customers advanced notice of the intent to formally move to the Emergency Stage, so wholesale customers can do final preparations (e.g., get their website ready). The advanced notice will likely be short in order to reduce the risk of unintended leaks to the press, which would complicate the process. Request continued cooperation, as identified under the Wholesale Customer Actions section.
- **WSAG:** SPU will provide updates on the water supply status and customer demand. For this stage, the role of the WSAG is to provide input on the implementation of the Emergency Stage.
- **Outreach:** Implement the communication and outreach plan elements developed for the Emergency Stage.
- **Ecology:** Continue participation on Ecology's Water Supply Advisory Committee to keep informed about State drought response and to provide Ecology with updates on forecasts for the Seattle regional water supply system.
- **DOH:** Update DOH on the shortage response and the need to be in the Emergency Stage.
- **Public Agencies:** Continue and intensify coordination with other City departments and public agencies (e.g., state and federal resource agencies, tribes, and other regional water suppliers, including Cascade Water Alliance and the Cities of Everett and Tacoma) about water supply conditions, projections, and potential actions.

- **SPU Employees:** Continue regular communication with Department employees to keep them up to date on goals, conditions, and actions.
- **Customer Inquiries:** Continue responding to customer inquiries, using the strategy established in the Voluntary Stage. Note that customer inquiries could show up in various ways, including social media, which may require a different strategic communication approach.
- **Revenue:** Continue assessing revenue implications and potential remedies, including reprioritizing expenses and potential withdrawals from the revenue stabilization fund.
- **Block Contracts:** Ensure block contract credits are initiated.
- **Police & Fire Enforcement:** Coordinate with police and fire departments requesting their assistance in promoting and enforcing emergency water restrictions.

3.4.7. Water Quality and Supply Management Actions

- **Data Collection:** Continue increased data collection actions (e.g., streamflows, snowpack conditions) and monitoring weather forecasts.
- **Modeling:** Continue increased SPU's computer modeling runs of projected supply, storage, demand and revenue scenarios.
- **Instream Flows:** Continue coordination with state and federal resource agencies and tribes, to review supply and fisheries conditions to determine appropriate instream flow levels. (See Cedar Instream Flow agreement and Tolt settlement agreement.)
- **Emergency Supplies:** Activate emergency supplies, such as the wellfields and Morse Lake Pump Plants, as appropriate. Consider drawing down Lake Youngs to meet supply needs.
- **Interties:** Activate interties, if not already implemented.
- **Reclaimed Water:** Continue promoting reclaimed water availability to tanker trucks for street cleaning, construction projects, landscape irrigation, dust control, etc.

3.4.8. Retail Customer Demand Actions

- **General Customer Actions:**
 - Implement the Emergency Stage customer demand reduction actions (that were determined in the Mandatory Stage).
- **City Departments:** Require that City departments reduce their water use including, but not limited to:

- **All Departments:**
 - Continue letting lawns go dormant and limiting plant watering to twice a week. Continue avoiding mid-day watering. Post explanatory signage if these recommendations cannot be implemented. (Certain exemptions will apply.)
 - Suspend all washing of fleet vehicles.
 - Continue not washing plazas, foyers, sidewalks, etc. with a hose. Use a broom instead. (Certain exemptions will apply where necessary for health and safety.)
 - Any applicable actions required of general retail customers
- **Finance and Administrative Services:**
 - Continue keeping decorative fountains off.
 - Continue using signage throughout buildings to encourage City employees (and the public where applicable) to reduce their water use.
- **SPU:**
 - Continue to suspend meter testing.
 - Continue to accelerate schedule to fix distribution system leaks.
- **Parks:** Move to the Emergency Stage of their WSCP and implement the associated demand reduction actions.
- **Transportation:** Continue suspension of street washing.
- **Fire Department:** Suspend training exercises that use water.
- **Exemptions from Water Use Restrictions:** Implement the exemptions for the Emergency Stage water use restrictions.
- **Rate Surcharges:** Consider implementing rate surcharges to accelerate customer compliance with the restrictions and/or recover lost revenue.

3.4.9. Wholesale Customer Actions

- **Move to Next Stage:** Implement the Emergency Stage of their WSCPs, in a manner consistent with SPU.
- **Outreach to Retail Customers:** Outreach to their retail customers, as documented in Appendix F.
- **Enforcement:** Continue to enforce water use restrictions within their own service areas.

- **Flushing:** Assess current water main flushing and reservoir cleaning activities to determine whether they should be accelerated to be completed prior to the peak season or reduced to conserve supply.
- **Alternative Sources:** Activate alternative supply sources, if appropriate.

4. Implementation for an Immediate Crisis

4.1. Background

This chapter focuses on implementing the WSCP when an event, such as a system failure, hinders SPU's ability to supply enough water to meet customer demands, and requires immediate action. Implementing the WSCP under these circumstances has both differences and similarities from implementation for a progressive event such as a drought.

Implementation of the WSCP for an immediate crisis is different in the following ways:

- **Lack of Preparation Time:** In a typical progressive event, SPU has weeks or months to prepare for action. In an immediate crisis, there is typically little to no preparation time and SPU takes actions within minutes, hours, and/or days.
- **Initial Stage:** In a typical progressive event, the WSCP is activated at the Advisory Stage and progresses sequentially through stages as necessary. In an immediate crisis, the WSCP is activated at one of the more aggressive stages, likely either the mandatory or emergency stage.
- **Larger Volume:** The volume of the water shortage for an immediate crisis could be more significant, thereby requiring larger-scale demand reductions.
- **Localized:** The immediate crisis could be very localized, thereby requiring demand reduction for only a limited geographic area.
- **Heightened Public Health & Safety:** The need to protect water quality and availability to support public health and safety are heightened, including issues such as minimizing any outages and having sufficient water and pressure for fire fighting.
- **SPU/City Emergency Response Plans:** Implementation of the WSCP would likely dovetail with implementation of other higher-level and/or more specific SPU and/or City of Seattle emergency response plans. Both SPU and the City have broader, all-hazards plans, such as SPU's Emergency Operations Plan and the City's Comprehensive Emergency Management Plan, that describe how their emergency management system is organized and managed in order to prepare for, prevent, mitigate, respond to, and recover from emergencies. SPU has numerous hazard-specific (e.g., earthquake) and site-specific (dams) emergency response plans that might be applicable.
- **Incident Command System:** The response would most likely be implemented under an Incident Command System (ICS), which is a nationally-sanctioned, standardized approach to the command, control, and coordination of emergency response. ICS is integral to the SPU and City emergency response plans mentioned above.

Implementation of the WSCP for an immediate crisis is similar to that of a progressive event in many of the considerations and principles discussed in Chapter 2 such as the need for flexibility, sharing the burden of the shortage, and the importance of addressing financial implications.

There are numerous crisis situations that could necessitate implementing the WSCP. Several examples are described below. Note that each of these situations has in fact occurred, yet they did not trigger formal activation of the WSCP due to mitigating circumstances. The need to activate the WSCP would depend on the amount of the supply impacted, the amount of time needed to restore the system to normal functions, how easily water could be re-routed to customers in the affected area, and the amount of water being used by customers given the season.

- **Major Transmission Pipeline Break:** A major transmission pipeline break from either the Tolt or the Cedar River supplies could require activation of the WSCP in an immediate crisis mode. Two major pipeline failures have occurred since 1987; however, they had minor impacts on customers due to system redundancy.
- **Temporary Treatment Plant Shut Down:** A temporary unplanned shut down of either the Cedar or the Tolt water treatment plants could require activation of the WSCP in an immediate crisis mode. In 2003, the Tolt Treatment Facility was shut down for approximately one week when a raw water inlet valve malfunctioned causing flooding of the plant. Because this occurred during the winter when demands were low, all retail and most wholesale customers were provided water from the Cedar system without disruption; a few wholesale customers were supplied from water stored at the plant's clearwell.
- **Major River Flooding Leading to High Turbidity:** Substantial flooding on the Cedar or Tolt Rivers could lead to high turbidity which might cause SPU to temporarily stop using that supply. This is particularly the case for the Cedar if major flooding occurred at the same time Lake Youngs was at or below normal minimum operating levels. In 1990, such an event occurred on the Cedar, when flooding exceeded the 100-year event. With the addition of filtration on the Tolt supply and the change in intake location on the Cedar supply, SPU's supply sources are much less vulnerable to impacts of turbidity than in the past.

4.2. Components

The following nine components are discussed below. (The definitions are repeated here so this chapter functions as a stand-alone chapter, which may be important in a crisis.) These are the same components as Chapter 3 (a progressive event) and the content is a hybrid of content from all four stages in Chapter 3. Therefore, while a stage is declared when implementing the WSCP for an immediate crisis, that stage may look slightly different than under a progressive event.

1. **Triggers** – Describes the general qualitative conditions that would trigger the stage. Note there are no pre-determined, quantitative conditions that trigger stages.
2. **Objectives** – Describes the overall objective of the stage.
3. **Stage Activation** – Describes who has the authority to enter the stage (either the SPU GM/CEO or the Mayor).
4. **Demand Reduction Goal** – Discusses the general, qualitative nature of the goal for the stage. Note there are no pre-determined, quantitative demand reduction goals for each stage.
5. **Key Public Messages** – Describes the key public messages for the stage. The messaging work is led by the Communications Lead.
6. **Coordination and Communication Actions** – Describes a variety of work necessary to coordinate and communicate with key stakeholders such as , wholesale customers, Ecology, Department of Health, natural resource agencies, tribes, City employees, the general public, etc. The overall work is led by the ICS Incident Commander, who makes assignments as appropriate.
7. **Water Quality and Supply Management Actions** – Describes work necessary to safeguard water quality and to maximize supply. This work is led by the Supply Management Lead.
8. **Retail Customer Demand Actions** – Describes work necessary to reduce customer demand. This work is led by the Demand Management Lead.
9. **Wholesale Customer Actions** - Describes actions required by each wholesale customer. Communication and monitoring of these actions is done by the Wholesale Customers Lead.

4.2.1. Triggers

- The appropriate stage (Voluntary, Mandatory, or Emergency) will be implemented when an event occurs that would prevent SPU from supplying enough water to meet customer demands and requires immediate action. (The selection of the appropriate stage will be based on the severity of the shortage.)

4.2.2. Objectives

- Maximize the amount of water delivered to customers and restore full supply capabilities as soon as possible.
- Achieve the demand reduction goals by voluntary or mandatory customer action. If activated at the Emergency Stage, restrictions may significantly impact customers' lives and businesses.
- Prepare for potentially moving to the next aggressive stage, if not already in the Emergency Stage.

4.2.3. Stage Activation

- The authority to declare a water supply emergency and activate the WSCP for an immediate crisis lies with the SPU GM/CEO according to SMC 21.04.500. However, the underlying event may warrant a proclamation of civil emergency, which would be declared by the Mayor per SMC 10.02.

4.2.4. Demand Reduction Goal

- Set demand reduction goal based on supply conditions and demand reduction potential consistent with any water use restrictions.

4.2.5. Key Public Messages

- **Activated WSCP:** We have activated the WSCP due to an immediate crisis. The details of the crisis are as follows *(to be developed at the time of the crisis)*.
- **Meet Demand Reduction Goal:** We are asking customers to reduce their water use to meet the demand reduction goal.
- **Mandatory Water Restrictions (If Activating at the Mandatory or Emergency Stage):** It is necessary to impose mandatory restrictions on certain water uses. Those restrictions are as follows: *(to be determined at the time of the crisis)*. There are exemptions for the following: *(to be determined at the time of the crisis)*.
- **Rate Surcharge:** If applicable, the rate surcharge is as follows: *(to be determined at the time of the crisis)*.
- **Water Quality:** If applicable, customers may find taste, odor or discolored water issues with their water due to changes in water supply operations *(be more specific if appropriate)*. While the water may not be pleasing, it is safe to drink.
- **Pressure Reduction:** If applicable, customers may experience a loss of pressure due to system operations. Customers with no water should call SPU at *(TBD)*.

4.2.6. Coordination and Communication Actions

- **Formal Declaration of Water Supply Emergency and/or Civil Emergency:** Depending on the event, the GM/CEO and/or Mayor make formal declarations of emergencies and activation of the WSCP.
- **Incident Commander & Team:** Identify the incident commander and the team members. An Incident Command System organizational chart is provided in Appendix A. Note that the functions of the Water Shortage Response Team used during a progressive application of the WSCP are incorporated into the Incident Command System.

- **Wholesale Customers:** Inform wholesale customers about the crisis and that the WSCP has been activated. Request their cooperation, as identified under the Wholesale Customer Actions section.
- **WSAG:** Formation of WSAG is not appropriate unless the event is anticipated to be of long duration. If formed, the role of the WSAG is to provide feedback on implementation of customer demand reduction actions. Early meetings will focus on explaining the crisis, the role of the WSAG, and educating the WSAG about the water system and the customer base.
- **DOH:** Inform the DOH about the crisis and the activation of the WSCP.
- **Public Agencies:** Coordinate with other City departments and public agencies (e.g., county, state and federal resource agencies, tribes, and other regional water suppliers, including Cascade Water Alliance and the Cities of Everett and Tacoma) as appropriate.
- **Outreach:** Develop and implement the initial communication and outreach plan. As described in the Communication and Outreach Framework in Appendix D, the plan should include the overall purpose, goals, audiences, and tools (e.g., FAQs, press releases, tips flyers). Additional outreach tools such as highway message boards, social media, or dial out phone systems might be used in an immediate crisis.
- **SPU Employees:** Establish a regular communication mechanism to keep Department employees up to date on goals, conditions, and actions.
- **Customer Inquiries:** Establish one point of contact for responding to customer inquiries.
- **Revenue:** Assess revenue implications and potential remedies, including reprioritizing expenses and potential withdrawals from the revenue stabilization fund.
- **Block Contracts:** Ensure block contract credits are initiated.
- **City Legislation:** Request Council to adopt legislation on water use restrictions, enforcement and any surcharges, if anticipate needing and not already in place.
- **Police & Fire Enforcement:** Coordinate with police and fire departments requesting their assistance in promoting and enforcing any water restrictions, if entering the Emergency Stage.

4.2.7. Water Quality and Supply Management Actions

- **Maximize Supplies:** Make system operational changes as needed to maximize the amount of water delivered to customers and restore system to normal operations.
- **Wells:** Begin to ready wellfields for use and activate, if appropriate.

- **Morse Lake Pump Plants:** Ready the pumping plants on Chester Morse Lake and commence pumping when gravity flow is no longer sufficient, if appropriate.
- **Interties:** Investigate using existing interties to increase supply availability and activate if appropriate.
- **Reclaimed Water:** Promote reclaimed water availability to tanker trucks for street cleaning, construction projects, landscape irrigation, dust control, etc.
- **Water Quality:** Assess water quality in reservoirs and in the distribution system to identify areas that may experience degradation with reduced consumption or changes to system operations. Increase monitoring if appropriate.
- **Instream Flows:** If reductions in instream flows would mitigate the impact of the event or are necessary, coordinate with state and federal resource agencies and tribes, to review supply and fisheries conditions and determine appropriate instream flow levels, including whether to provide supplemental flows or reduce to below normal minimum flows. (See Cedar Instream Flow agreement and Tolt settlement agreement.)

4.2.8. Retail Customer Demand Actions

- **General Customer Actions:**
 - Determine and implement the list of customer demand reduction actions requested/required. A list of potential actions customers can take to reduce water use is provided in Appendix E. The actual actions selected will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed. Additionally, establish and implement appropriate exemptions. Appendix G includes possible exemptions to water use restrictions for SPU to consider. Finally, determine appropriate enforcement strategies, if appropriate.
- **City Departments:** Request that City departments reduce their water use in affected areas. The specific actions requested will be determined during implementation of the WSCP, however likely actions include the following:
 - **All Departments:**
 - Let lawns go dormant and limit plant watering to twice a week. Avoid mid-day watering. Post explanatory signage if these recommendations cannot be implemented. (Certain exemptions will apply.)
 - Either wash fleet vehicles only if using facilities that recycle the water or suspend all washing of fleet vehicles, depending on the severity of the crisis.
 - Do not wash plazas, foyers, sidewalks, etc. with a hose. Use a broom instead. (Certain exemptions will apply where necessary for health and safety.)

- Any applicable actions requested of general retail customers
- **Finance and Administrative Services:**
 - Turn off decorative fountains
 - Post signage throughout buildings to encourage City employees (and the public where applicable) to reduce their water use.
- **SPU:**
 - Suspend water main flushing and reservoir cleaning unless needed to support restoration to normal operations
 - Suspend meter testing
 - Accelerate schedule to fix distribution system leaks
- **Parks:** Request that the Parks and Recreation Department activate their Water Shortage Response Plan.
- **Transportation:** Suspend street washing
- **Fire Department:** Either limit or suspend training exercises that use water, depending on the severity of the crisis.
- **Hydrant Permits:** New hydrant permits for temporary water service will be either restricted to essential services or rescinded (unless necessary for public health), depending on the severity of the crisis.
- **Rate Surcharges:** Consider implementing rate surcharges to accelerate customer compliance with the restrictions and/or recover lost revenue.

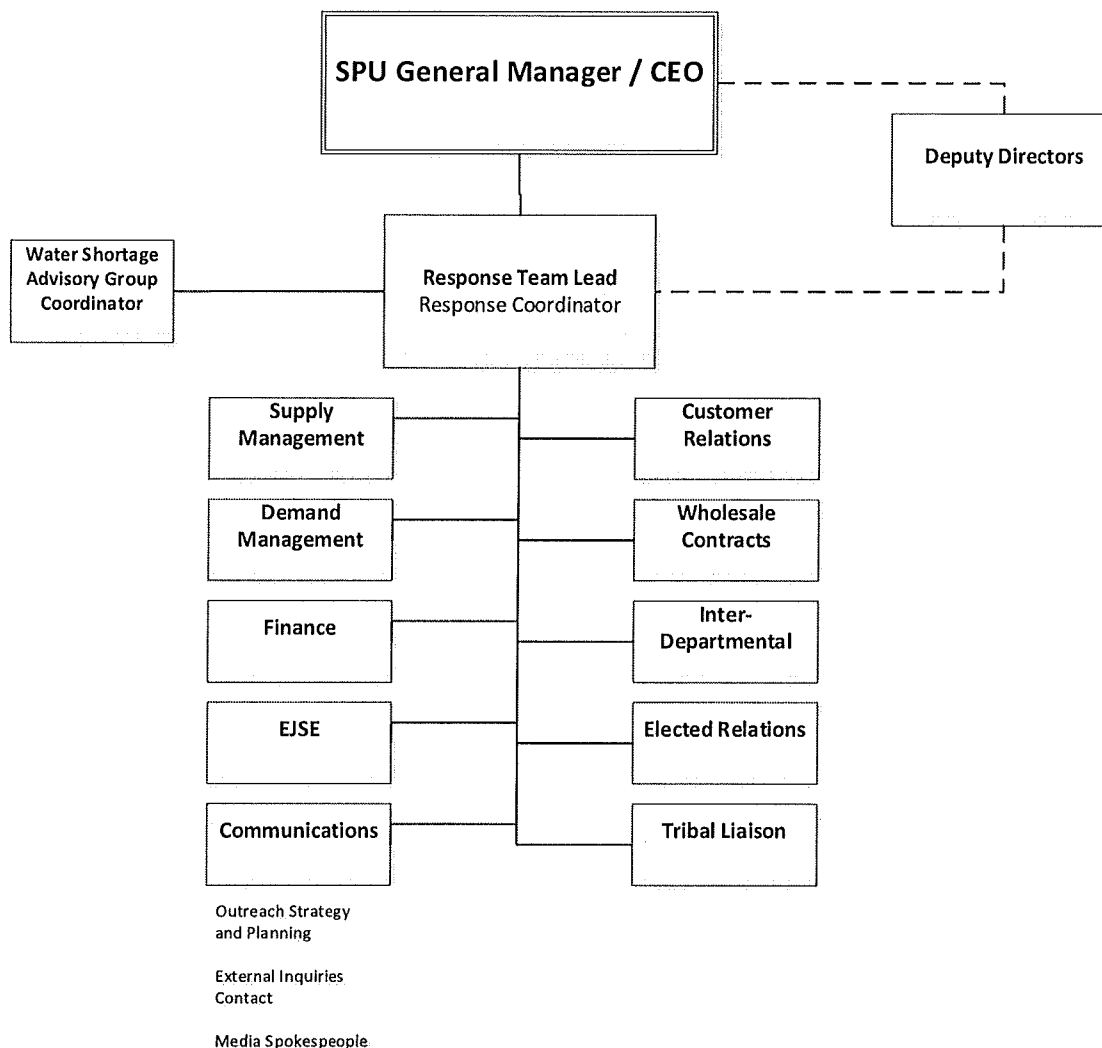
4.2.9. Wholesale Customer Actions

- **Activate Plans:** Activate their own WSCPs, in a manner consistent with SPU, if in affected area.
- **Alternative Sources:** Activate alternative supply sources, if appropriate and necessary.
- **Flushing:** Assess current water main flushing and reservoir cleaning activities to determine whether they should be suspended.
- **Outreach to Retail Customers:** Outreach to their retail customers, as documented in Appendix F.
- **Enforcement:** Enforce any water use restrictions within their own service areas.

Appendix A – Water Shortage Response Team Membership and Roles

Water Shortage Response Team

The Water Shortage Response Team is SPU's internal team whose role is to evaluate conditions, advise the SPU General Manager/CEO on supply and demand actions, coordinate with other parties, and make assignments to SPU staff as needed to respond to the shortage. The Team is appointed by the SPU GM/CEO. An organizational chart and an explanation of the roles is provided below.

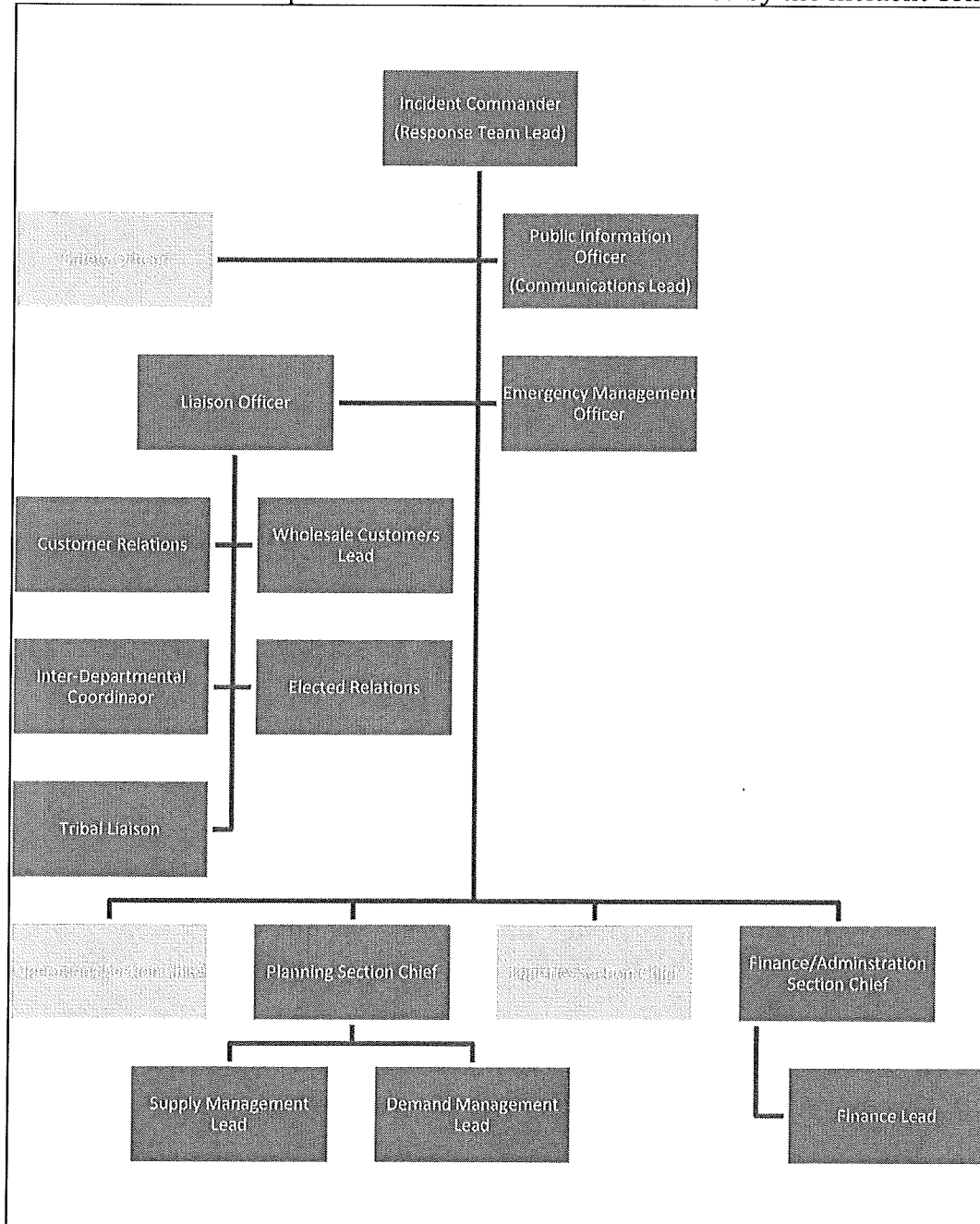


- **SPU GM/CEO** – Overall direction on the response. Weighs in on Team recommendations for moving through response stages, demand management actions, and key messages.
- **Deputy Directors (Executive Team)** – Input to SPU GM/CEO for response. May include Chief Administrative Executive and Water Line of Business Executive.
- **Response Team Lead** – Lead the overall water shortage response effort including issue coordination, information gathering and dissemination, key support staff assignments, role clarification, and communication with broad array of interested parties.
- **Water Shortage Advisory Group Coordinator** – Purpose and membership of the Water Shortage Advisory Group (WSAG) is described in Appendix B. The WSAG Coordinator works with SPU GM/CEO to identify and invite members, and facilitates meetings and communications with WSAG.
- **Supply Management Lead** – Overall guidance on supply management, drinking water quality and operations, status of non-revenue water use in operations, and issues related to potential alternative supplies/interties. Provide guidance regarding watershed activities that may impact water supply. Provide water supply condition reports, forecasts, production reports, operational needs, and modeling identification and oversight. Provide guidance regarding instream flows/fisheries, river analyses, river biological assessments, and coordinate with Cedar River Instream Flow Commission and Tolt Fisheries Advisory Committee. Prepare for use of and report on issues related to the Morse Lake Pump Plants.
- **Demand Management Lead** – Customer water use reduction actions management and messaging, estimates of water use savings, implementation cost estimates, and communication with landscapers, nurseries and large water users (commercial and residential). Provides water consumption tracking, reporting and forecasting.
- **Finance Lead** – Expected lost revenue estimates, budgets and charge number set-up for shortage-related activities, and process necessary to access revenue stabilization fund, if needed.
- **Environment Justice and Service Equity Lead** – Ensure EJSE objectives are addressed in WSAG, demand management, customer relations and communication activities.
- **Communications Lead** – Messaging, employee communication, media relations, press releases, marketing, advertising, social media, key contact for interagency Public Information Officers (PIOs), and coordination on messaging with Cascade Water Alliance and the Cities of Everett and Tacoma.
 - **Outreach Strategy and Planning Lead** – Responsible for defining outreach goals, objectives and strategies early in event.
 - **Media Spokespeople** – Small group of subject matter experts (e.g., supply management, demand management) for media interviews.
 - **External Inquiries Contact** – Point person for all customer inquiries, responsible for timely and consistent response.

- **Customer Relations Lead** – Communicate with and assist with message development for the call center and key accounts.
- **Wholesale Contracts Lead** - Provide coordination with wholesale customers. Work with Finance on block contract billing adjustments.
- **Inter-Department Coordinator** -- Point person for inter-city department coordination, separate from customer relations, to work with one-city perspective and coordination with Council and Mayor's Office.
- **Elected Relations** – Coordinate briefings with City Councilmembers and Mayor, and any legislation needed.
- **Tribal Liaison** – Coordinates with key Tribes.

Water Shortage Response Team Integrated in Incident Command System

During an immediate crisis, the underlying event would most likely trigger an incident command response by SPU. In this instance, the functions of the Water Shortage Response Team can be integrated into the Incident Command System as shown below by the darker shaded boxes. The Response Team Lead role would be filled by the Incident Commander.



Appendix B – Water Shortage Advisory Group Membership

The Water Shortage Advisory Group (WSAG) is a team of key customers and stakeholders whose role is to advise the Water Shortage Response Team on requests or actions made to customers regarding utility water shortage response actions and programs. Membership should represent diverse perspectives. Potential members are shown in the table below. The total number should be no more than 20 organizations.

Category	Potential Member
Wholesale Customers	- Water Supply Operating Board representative - Cascade Water Alliance
State and County Agencies	- Department of Health, NW Regional Office - Department of Ecology - Washington Department of Fish and Wildlife - King County Department of Natural Resources
Federal Agencies	- US Army Corps of Engineers - National Marine Fisheries Service
Landscape and Nursery Industry	- Washington State Nursery and Landscape Association - Washington Association of Landscape Professionals - Larger Nurseries (e.g., Molbaks, Sky, Swansons)
Business Community	- Seattle Chamber of Commerce - Port of Seattle or Seattle/Tacoma Port Alliance - Manufacturing Industrial Council of Seattle
Environmental	- Cedar River Council or Friends of the Cedar - Washington Environmental Council - Environmental Coalition of South Seattle
Tribal	- Muckleshoot Indian Tribe - Tulalip Tribes
General Public	Water System Advisory Committee Chair
City Departments	- Facilities and Administrative Services - Seattle Parks and Recreation - Seattle City Light - Transportation
Franchisees	City of Shoreline
Regional Water Suppliers	- Tacoma Water - City of Everett
SPU Staff	- Water Shortage Response Team Lead - Demand Management Lead - Communications Lead - ESJE Lead

Appendix C – Previous WSCP Implementations

SPU has implemented its Water Shortage Contingency Plan (WSCP) six times. Each implementation was due to drought, however each of those implementations was different due to the unique characteristics of each drought. SPU has modified both the WSCP and system operations during drought based on lessons learned from these previous implementations.

The table below highlights a few key aspects of each implementation. More detailed summaries are provided below.

Year	Furthest Stage	Type of Drought	Duration	Statewide Drought
2015	2. Voluntary	Winter/Spring (low snowpack) and Summer (hot/dry temperature)	Late-July to late-Nov	Yes
2005	1. Advisory	Winter/Spring (low snowpack)	Mid-Mar to early-July	Yes
2002	2. Voluntary	Fall/Early Winter (late fall rains)	Late-Oct 2002 to January 2003	No
2001	2. Voluntary	Winter/Spring (low snowpack)	Mid-March to early-Sept	Yes
1992	3. Mandatory	Winter/Spring (low snowpack)	Mid-May to mid-Oct	No
1987	3. Mandatory	Summer/Fall (hot/dry temperature) and Fall/Early Winter (late fall rains)	Early August 1987 to February 1988	N/A

2015 Drought

Very low snowpack levels caused statewide concerns about drought. To account for the lack of snow, the Tolt and Chester Morse Reservoirs were operated to store more rainfall than typical during the late winter and early spring, reaching refill targets earlier than normal. By mid-May, the Governor had declared a statewide drought emergency, but noted that the large municipal water suppliers in the Puget Sound region, such as Seattle, Tacoma and Everett, had adequate reservoir storage to meet their customers' needs and did not anticipate water shortages. Subsequently, the region experienced historical hot and dry conditions causing rapid drawdown of storage at the reservoirs. SPU, in close coordination with Everett and Tacoma, activated the Advisory Stage of their water shortage contingency plans in late July. In August, the three utilities entered the Voluntary Stage of their plans and requested customers to reduce their water use by 10 percent, which was achieved. By late October, water levels in the Chester Morse Reservoir were at lower than typical levels, and SPU used its new pumping plant on Morse Lake to access water stored there. Pumping lasted for five days, when significant rains occurred. During the drought SPU was able to maintain stream flows above the normal guaranteed levels at all times except for 7 days between October 24th and October 30th. During this 7-day period, with the approval of the Cedar River Instream Flow Commission, stream flows were managed to provide flow volumes that were below low normal flows and above critical flows. In November, the three utilities moved back into the Advisory Stage of their water shortage contingency

plans, and then deactivated their plans, when regional water supply conditions returned to normal.

2005 Drought

SPU watersheds experienced the lowest snowpack in 60 years, one of the driest winters on record, and warmer than normal winter temperatures. Water managers responded by activating the Advisory Stage of the WSCP, reducing system water use and maximizing the amount of water held in storage using the dynamic rule curve. In effort to help better position supply for meeting instream resource needs during the summer and fall, the Cedar River Instream Flow Commission agreed to forgo allocation of non-firm supplemental stream flows during the spring. As a result of this active management and nearly average rainfall in the spring, SPU was able to return to normal operations by summer that year.

2002 Drought

The fall rains failed to materialize at the usual time and SPU began mobilizing the pumps on Morse Lake. The Voluntary Stage of the water shortage contingency plan was activated, the public was made aware that supplies were low, and there was the possibility of water restrictions if dry weather continued.

2001 Drought

Snowpack appeared to be very similar to that of 1992, and water supply forecasts made through the end of the year looked dire in early March. Snowpack ended up peaking at 65% of normal, and reservoirs were full or nearly full by June. Nonetheless, with a statewide drought emergency in effect, Seattle asked customers starting in early April, to voluntarily reduce water use by 10 percent. This was rescinded in early August.

1992 Drought

The winter was unusually warm, and snowpack and flows into the storage reservoirs were at record low levels. In late February, it was evident that there was insufficient snowpack to fill the storage reservoirs, and that the likelihood of recovery by June 1 due to rainfall was low. A number of measures were taken to maximize available supply (e.g., reducing system flushing, adjusting stream flow levels, etc.) and to reduce demand. In May, a number of mandatory curtailment actions were implemented, including a ban on lawn watering. This resulted in an average consumption reduction of 25 to 30 percent below normal throughout the summer. Tribes, state resource agencies and the Army Corps of Engineers played a significant role in cooperating to maximize available water supply. In addition, other measures were taken to increase available supply including initiating an intertie with Renton and accelerating the construction of a second pump plant for use of "dead storage" at Chester Morse Lake. The mandatory restrictions were rescinded in September as supply levels returned to normal with the onset of fall rains.

1987 Drought

Storage reservoirs were at normal levels on June 1, but the summer weather was unusually warm and dry. Higher than normal outdoor water use accelerated the drawdown of the storage reservoirs. To reduce demand, in early August lawn watering was restricted to no

more than once every three days and customers were urged to voluntarily curtail other water uses. These actions reduced demand by approximately 10 percent. In early fall, an emergency pumping station was installed at the Chester Morse Lake reservoir to pump "dead storage" in case the reservoir level fell below the lake's natural outlet.

Throughout the fall, precipitation continued to be below normal. The water supply system was managed and adjusted to obtain the maximum supply available (e.g., relying on Lake Youngs more than normal). In November 1987 and January 1988, the Chester Morse Reservoir was low enough to require pumping, and it was not until February 1988 that rainfall began refilling the storage reservoirs.

Appendix D – Communication and Outreach Framework

This document is intended to provide a framework for communication and outreach efforts during implementation of the Water Shortage Contingency Plan. The actual communication and outreach plan will be developed during implementation of the WSCP. The initial plan will be developed in the Advisory Stage, during which SPU plans for the potential of moving into the Voluntary Stage. The communication and outreach plan will be modified as implementation of the WSCP continues, especially if SPU moves into the Mandatory and/or Emergency Stage.

The communication and outreach plan should include the following elements: overall purpose, goals, audience, and tools. More information on each of these elements is provided further below. Selected examples of tools used during the 2015 WSCP implementation are also included.

The following steps should be used to develop the communication and outreach plan:

1. Confirm/modify the overall purpose
2. Confirm/modify the goals
3. Identify which audiences to target and/or to prioritize
4. Identify which tools to develop
5. Match the audiences and the tools
6. Identify staff responsible for developing the tools
7. Identify staff responsible for implementing the communication/outreach
8. Track the implementation
9. Modify as necessary

Overall Purpose

The overall purpose of the communication and outreach effort is to make sure everyone is aware of the "drought/shortage message", which consists of the following components:

1. We are experiencing a drought/shortage
2. We are asking everyone to help by.....(*to be determined for appropriate WSCP stage*)
3. We have suggestions/requirements on how to reduce water use
4. Also see the "key public messages" under each WSCP stage

Goals

There are three goals of the communication and outreach effort, as follows:

1. Build awareness
2. Create a community presence
3. Targeted messaging

Audiences

There are a variety of audiences for the communication and outreach efforts. Some audiences are broad in nature, while others are very specific. The seven main audiences, including locations/organizations/other subcategories, are as follows:

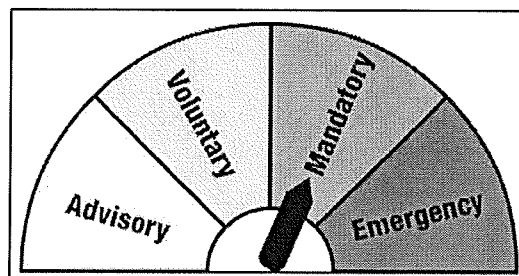
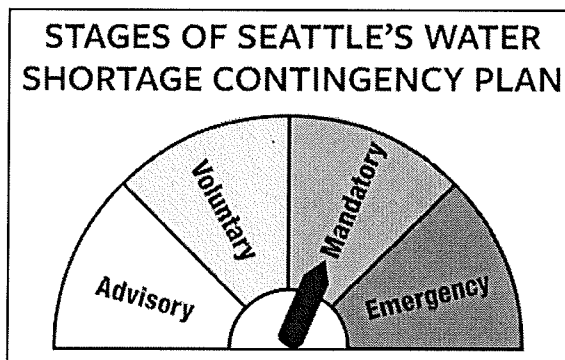
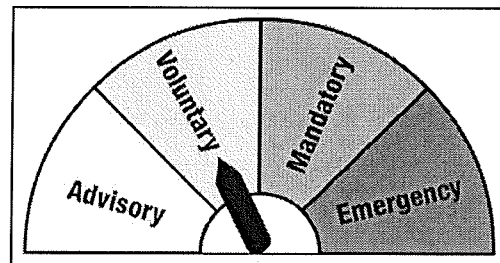
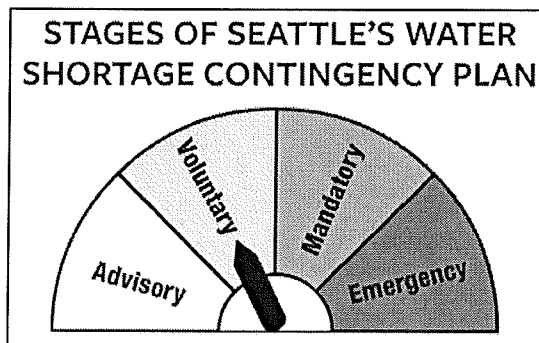
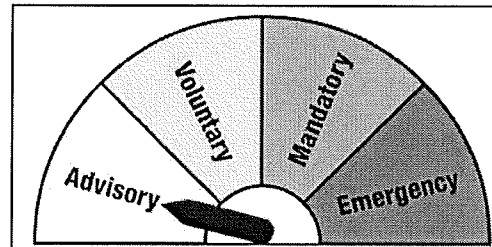
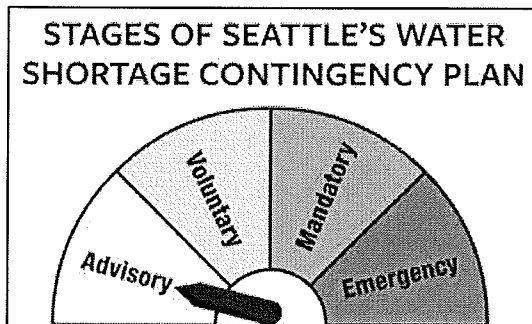
1. General Public
 - City of Seattle community centers
 - City of Seattle libraries
 - City of Seattle neighborhood service centers
 - City of Seattle Department of Neighborhoods
 - SPU community advisory committee
 - Community events
 - Farmers markets
 - Multifamily property management associations
 - Churches
2. Irrigation Community
 - Area parks and recreation departments
 - Schools (if shortage occurs during the school year when irrigation of ballfields is most likely)
 - Prominent nurseries
 - Professional landscape/nursery organizations
 - Garden Hotline
 - 3rd billing tier customers (assumed to be high irrigation users)
3. Large Users (other than irrigation community)
 - SPU key services account representatives
4. Business Community
 - Chambers of commerce
 - Business improvement districts
 - Commercial building operator associations
 - Hotel and restaurant association(s)
 - City of Seattle Office of Economic Development
5. Environmental Community
6. Non-English Speakers
 - Ethnic organizations
 - SPU affinity groups
7. City of Seattle Employees

Tools

There are a variety of tools that can be used for the communication and outreach efforts. Tools used, or considered, for previous WSCP implementations are show below. The list includes both paid and “earned” media. Note that tools may change over time, expecially as changes occur in technology and customers’ preferences.

1. 4-Stages graphic
2. Utility website
3. Tips/restrictions flyer
4. Regular utility publication (bills, bill inserts, newsletters, etc)
5. Press release
6. FAQ
7. Print ad
8. Television ad
9. Radio ad
10. Web ad
11. Social media posting (Facebook, Twitter, Nextdoor, blogs, etc)
12. Signage (building, vehicle, park, etc)
13. Email
14. Letter/postcard
15. Phone call
16. Presentation at meeting
17. Industry newsletter
18. Drought message in email signature line
19. Recording for on-hold callers to utility customer service phone number

4-Stages Graphic (Branded for Seattle and unbranded for others)



Website



Saving Water Partnership

Seattle and participating water utilities

[About Us](#) | [Contact Us](#)

[Home](#) [Lawn & Garden](#) [Indoors](#) [Businesses](#) [Resources](#) [Students & Teachers](#) [Rebates](#)

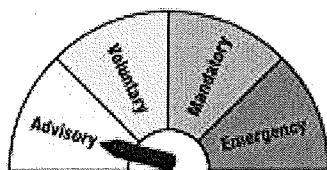
who we are

The Saving Water Partnership is a group of local water utilities in Seattle and King County working together to help customers save water and money.



Advisory Stage Activated

The Seattle regional water system is in the Advisory Stage of its Water Shortage Contingency Plan. Read a weekly report on water supply conditions for Seattle.



Stages of Seattle's water shortage contingency plan.

Advisory Stage Top Tips

- [View All list of advisory stage tips](#)
- **Water Early or Late** - Water before 8 a.m. or after 7 p.m. which reduces evaporation.
- **Water Deep, Not Frequently** - It's better to have one or two deep waterings, rather than several shallow waterings.
- **Fix Leaks** - Fix obvious indoor and outdoor leaks such as at faucets, hose bibs, and sprinkler spray heads. Check for less obvious leaks such as silent toilet leaks. Put several drops of food coloring in your toilet tank; after 10 minutes if you have color in the toilet bowl, you have a flapper leak.
- **Wash Vehicles Wisely** - Wash your vehicle(s) at locations that recycle the water.
- **Use a Broom, Not a Hose** - Use a broom, rather than a hose, to clean sidewalks, driveways and patios.
- **Wash Full Loads** - Wait until your clothes washer and dishwasher are full before starting.

Toilet Rebates - A Great Way to Save

- \$75 rebates for single-family customers
- \$75 and \$150 rebates for multifamily customers



Water Young Trees Efficiently



Water young trees efficiently using a water bag. Trees planted 5 or fewer years ago need 15-20 gallons of water twice a week to survive.

Let Us Know What You Think!

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gardening videos

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online tools

[Sprinkler calculator](#)
[Water budget calculator](#)
[Compost calculator](#)



participating utilities

[View Partner Map](#)

- [Cedar River Water and Sewer District](#)
- [City of Bellingham](#)
- [City of Everett](#)
- [City of Mercer Island](#)
- [City of Seattle](#)
- [Cedar Creek Utility District](#)
- [Highline Water District](#)
- [Kirkland Water District](#)
- [Northshore Utility District](#)
- [Olympic View Water & Sewer District](#)
- [Seattle Public Utilities](#)
- [Snohomish County Water and Sewer District](#)
- [Water District 129](#)
- [Water District 145](#)
- [Water District 149](#)
- [Water District 150](#)
- [Water District 1113](#)
- [Water District 1125](#)
- [Woodinville Water District](#)
- [Partner contact information](#)

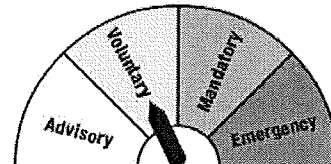
Tips Flyer (Voluntary Stage; co-branded for SPU, Everett & Tacoma)

VOLUNTARY STAGE TOP TIPS

Seattle
Public
Utilities



STAGES OF WATER SHORTAGE
CONTINGENCY PLAN



Seattle, Everett and Tacoma are asking customers to voluntarily reduce water use by 10 percent. We are working together to help manage water supplies for people and fish during this unprecedented hot and dry weather and higher-than-normal water use. Here are some great tips to help you achieve that 10% reduction. For more information visit www.savingwater.org.

Please consider doing the following:

Outdoors Tips



- Let your lawn go dormant and limit plant watering to twice a week.
- Water plants before 8am (best) or after 7pm.
- Wash your vehicle(s) at locations that recycle the water.
- Do only essential pressure washing.
- Minimize refilling swimming pools and hot tubs.
- Turn off water features.
- Fall is the best time for planting.

More Outdoor Tips click below
www.savingwater.org/LawnGarden/index.htm

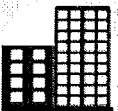
Indoors Residential Tips



- Reduce your showering time.
- Check for and fix leaks.
- Wash only full loads of laundry and dishes.
- Turn off the tap while brushing your teeth or shaving.
- Don't pre-rinse dishes.
- If purchasing fixtures/equipment, choose water-efficient models.

More Indoor Residential Tips click below
www.savingwater.org/Indoors/index.htm

Indoors Businesses Tips



- Encourage reduced showering times at your facilities.
- Serve water only on request.
- Check for and fix leaks.
- Wash only full loads of laundry and dishes.
- Provide new towels only on request.
- Check cooling towers for overflow and excessive blowdown.
- If purchasing fixtures/equipment, choose water-efficient models.

More Indoor Business Tips click below
www.savingwater.org/Businesses/index.htm



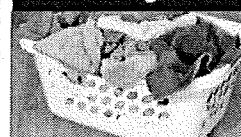
**Limit plant watering
to twice a week.**



**Water plants before
8am (best) or after 7pm.**



**Reduce your
showering time.**



**Wash only full loads of
laundry and dishes.**



**Serve water only
on request.**

8/10/15

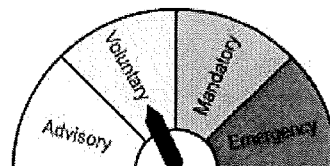
Tips Flyer (Voluntary Stage; branded by wholesale customer)

Voluntary Stage Top Tips



Woodinville Water District
17238 NE Woodinville-Duvall Rd
P O Box 1390
Woodinville WA 98072
(425) 487-4100

STAGES OF WATER SHORTAGE CONTINGENCY PLAN



Seattle, Everett and Tacoma are asking customers to voluntarily reduce water use by 10 percent. We are working together to help manage water supplies for people and fish during this unprecedented hot and dry weather and higher-than-normal water use. Here are some great tips to help you achieve that 10% reduction. For more information visit www.savingwater.org.

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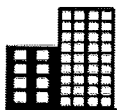
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Indoors Businesses Tips

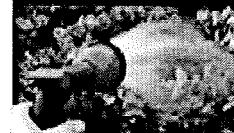


- Encourage reduced showering times at your facilities.
- Serve water only on request.
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- Wash only full loads of laundry and dishes.
- Provide new towels only on request.
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More Indoor Business Tips click below
www.savingwater.org/Businesses/index.htm



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Wash only full loads of
laundry and dishes.



Serve water only
on request.

8/10/15

Tips Flyer (Voluntary Stage; translated; co-branded for SPU, Everett & Tacoma)

VOLUNTARY STAGE TOP TIPS 自願性階段省水妙招

Seattle, Everett and Tacoma are asking customers to voluntarily reduce water use by 10 percent. We are working together to help manage water supplies for people and fish during this unprecedented hot and dry weather and higher than normal water use. Here are some great tips to help you achieve that 10% reduction. For more information visit www.savingwater.org.

Please consider doing the following:

Outdoors Tips

- Let your lawn go dormant and limit plant watering to twice a week.
 - Water plants before 8am (best) or after 7pm.
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Indoors Residential Tips

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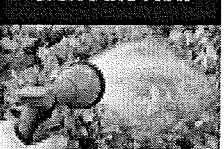
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 - If purchasing fixtures/equipment, choose water-efficient models.
- More Indoor Business Tips click below
www.savingwater.org/Business/index.htm

缺水各阶段之应急计划



每周浇水限于两次。



早上8点前 (最佳时机) 或晚上7点后再浇水。



减少淋浴时间。



洗衣机和洗碗机满了才洗。



客人提出要求时才送水。

西雅图, 埃弗雷特市 (Everett) 和塔克马市 (Tacoma) 请求各用户自愿性地减少 10% 的用水。我们正面临史无前例的干热天气, 以及比平常更高的用水需求, 我们需要合作管理, 以满足居民和鱼类的需要。以下为您列出一些能达到省水 10% 的妙招。欲进一步了解, 请参考以下网站: www.savingwater.org.

请参考以下建议:

户外妙招

- 让您的草坪休眠, 每周浇水限于两次。
- 早上 8 点前 (最佳时机) 或晚上 7 点后再浇水。
- 到自动收水的洗车站洗车。
- 不到必要时不用高压冲洗。
- 将游泳池和热水池换水的频率降到最低。
- 尽量关水关掉。
- 秋天是种植的最佳时机。

更多户外省水妙招, 请参考以下网站:
www.savingwater.org/LawnGarden/index.htm

室内居家妙招

- 减少淋浴时间。
 - 检查并修理漏水的地方。
 - 洗衣机和洗碗机都等到满了再开启。
 - 刷牙和刮胡子时请把水关掉。
 - 洗碗前不要预冲。
 - 购买家具或家电时, 选择有省水设计的产品。
- 更多室内居家省水妙招, 请参考以下网站:
www.savingwater.org/Indoors/index.htm

室内商家妙招

- 鼓励客人在您的设施内减少淋浴时间。
 - 客人提出需求时才送水。
 - 检查并修理漏水的地方。
 - 洗衣机和洗碗机都等到满了再开启。
 - 客人提出需求时才提供新毛巾。
 - 检查冷却水塔是否有溢出或过多的蒸气排放。
 - 购买家具或家电时, 选择有省水设计的产品。
- 更多室内商家省水妙招, 请参考以下网站:
www.savingwater.org/Business/index.htm

Seattle
Public
Utilities



Free interpretation available. (206) 684-3000
若需免费口译之服务, 请拨打 (206) 684-3000

Reprinted Greenleaf 1/11/15

Regular Utility Publication (SPU “@ Your Service” utility bill insert Sept-Oct)

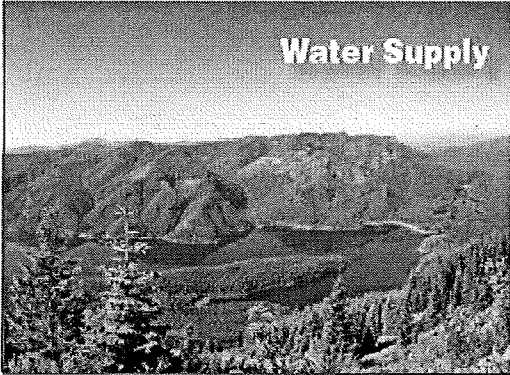


September - October

@ Your SERVICE

Information about your water, drainage, wastewater and solid waste utility services.

Water Supply



The record breaking hot summer has left many Seattle residents looking forward to fall and winter rains. Until those steady rains return, Seattle Public Utilities asks that you manage your water use thoughtfully by doing the following:

- Put two inches of mulch on planting beds and around trees.
- If you are still watering outdoors, do so before 8 a.m. or after 7 p.m.
- Wash only full loads of laundry and dishes.
- Wash vehicles only at a location that recycles water.
- Use a broom – not a hose to clean decks, patios, driveways and sidewalks.
- Turn off the tap while brushing your teeth or shaving.
- Fix leaking toilets and dripping sinks.

For more tips on using water wisely, visit www.savingwater.org.

Using Water Carefully Benefits Salmon



What do salmon and saving water have to do with each other? Conserving water in the summer and fall helps leave water in the rivers for salmon and wildlife. Your actions can help save money on your water bill and protect salmon and their freshwater habitat. You can see your efforts pay off when salmon make their annual migration home to our local streams. Find out when and where salmon are returning by visiting www.kingcounty.gov/salmon and clicking on “Salmon SEEsou.”



See Salmon at Carkeek Park

See the hundreds of chin salmon return to Piper’s Creek in Carkeek Park. Join volunteers from the Salmon Stewards program Saturdays and Sundays, November 7 – December 6, from 11 a.m. to 2 p.m. and learn how you can help keep salmon habitat healthy. There will be children’s activities, food, hot drinks, and music at the Piper’s Creek Salmon Celebration, Friday, November 27, from 11 a.m. to 1 p.m.

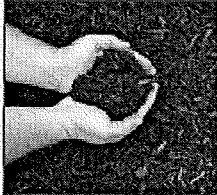


Visit www.seattle.gov/protectourwaters to learn more.

Questions? Email Bill Malatinsky at bill.malatinsky@seattle.gov or call 206-684-5999 or visit <http://bit.ly/SalmonStewards>

Fall Garden and Landscaping Water Conservation Tips

Fall is an ideal time to prepare your landscape and garden for next year.



- Add 2 to 3 inches of mulch (fall leaves, woodchips or compost) to the surface of bare soils. Mulch helps protect plant roots during freezing weather.
- Turn off your automatic sprinkler system. Watering your plants in the fall can delay them from preparing for dormancy, making them more susceptible to early freezes.
- Plant new trees, shrubs or perennials! Cooler air and warm soil help plants develop strong roots ahead of our dry summers.

Gardening questions?

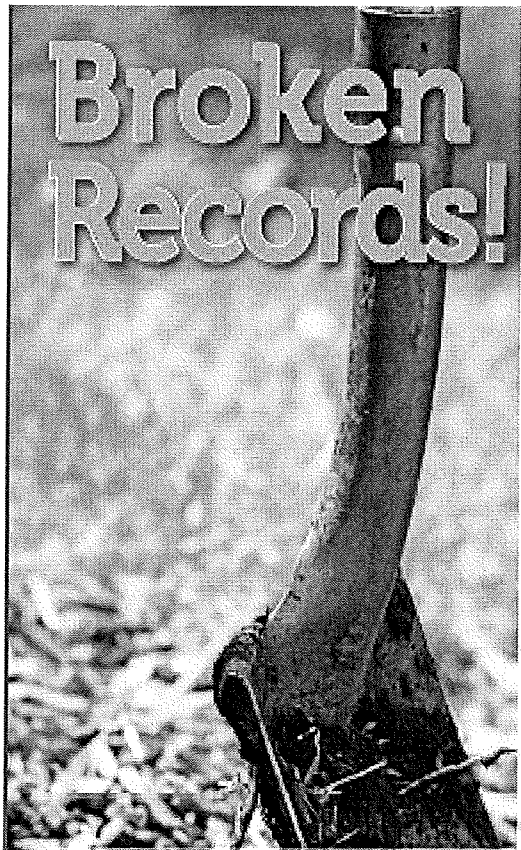
Contact the Garden Hotline at (206) 633-0224 or email from www.gardenhotline.org.

Go to www.savingwater.org for a compost calculator, fall planting video and much more.

Green Seattle Day

Join us for the 10th Annual Green Seattle Day on Saturday, November 7 to plant the future forest of Seattle in your favorite park! This will be a celebration of Seattle’s urban forest and everyone can help! Help us to plant trees and other plants in parks throughout the City, to keep Seattle healthy and green into the future. For more information and to sign up, visit us at www.greenseattle.org, or call (206) 905-6943.

Regular Utility Publication (SPU "Curb Waste & Conserve" newsletter Fall)



Broken Records!

How to Winterize Your Automatic Irrigation System

- Turn off the water supply to the irrigation system.
- Turn the controller dial to the "Off" setting.
- Insulate any above ground pipes, backflow prevention devices, and hose bibs.
- Open each valve to release water pressure inside the pipe.
- Be sure to drain any water that might freeze out of the irrigation system.
- Remove any cup or bowl from rain sensor, and cover the sensor.

Seattle Public Utilities

Have you broken anything lately? Seattle has: heat records! Seattle has been hotter and drier than normal, and more warm days may be coming. With warm weather comes the need to conserve water. Not just for drinking, but for healthy fish habitat too! Now is the time of year when salmon return and need higher river and stream flows to successfully spawn. Here are some tips to help you use water wisely on your landscape:

STOP WATERING. As temperatures become cooler and the days shorter, plants enter the initial phase of dormancy when no water is needed. Turn off your automatic irrigation controller. Fix leaky sprinkler heads and broken nozzles. Prepare your irrigation system for winter.

WEED AND MULCH. After your fall clean-up and weeding, add a 2-3 inch layer of mulch to the soil surface. Arborist wood chips work best around woody plants and trees, while fall leaves or compost should go around perennials. Mulch helps protect plant roots during freezing weather. Mulch also helps reduce water evaporation, blocks weeds, prevents erosion by winter rains and feeds the soil.

WATER YOUNG TREES EFFICIENTLY. If the rains haven't returned yet, water young trees efficiently using a water bag. Trees planted 5 or less years ago need 15-20 gallons of water twice a week to survive.

QUESTIONS? Contact the Garden Hotline for free answers to your gardening questions! (206) 633-0224 or www.gardenhotline.org.

Visit www.savingwater.org for more watering tips and lots of information about environmentally friendly lawn and garden care.

Print Ads (Seattle Times)

Seattle
Public
Utilities

Our drinking water
isn't just for us.

Please keep doing your part
to reduce water use.

Savingwater.org



Seattle's water gives life to salmon habitat
in the Tolt and Cedar Rivers

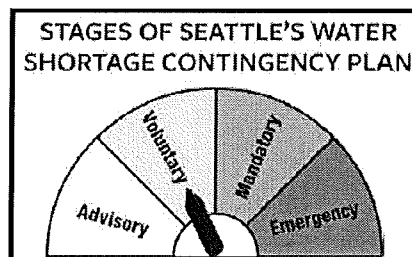
Signage (Kitchens in many City of Seattle buildings)



REMINDER TO CITY EMPLOYEES

- AS OF AUGUST 11, WE ARE IN THE VOLUNTARY STAGE OF OUR WATER SHORTAGE CONTINGENCY PLAN.
- EVERYONE IS ASKED TO VOLUNTARILY REDUCE WATER USE BY 10%.
- PLEASE BE MINDFUL OF YOUR WATER USE. FOR EXAMPLE, DON'T LEAVE WATER RUNNING IN THE KITCHEN OR BATHROOM.
- GO TO WWW.SAVINGWATER.ORG FOR WATER-SAVING TIPS.

Our customers are stepping up to the plate.....let's do our part!



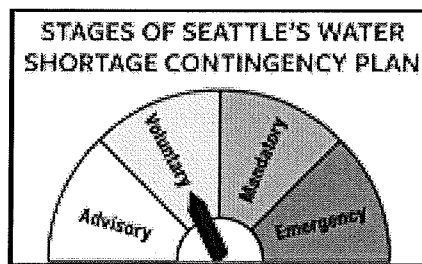
Signage (Doors of many City of Seattle buildings)



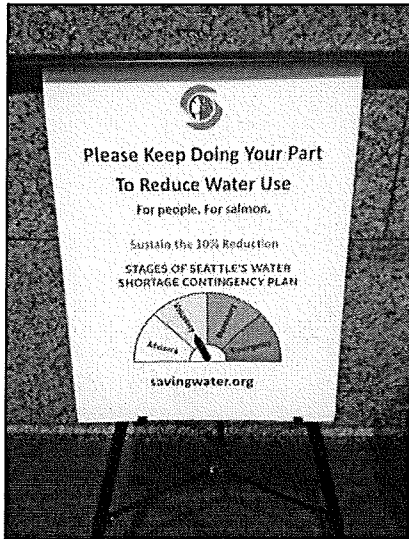
PLEASE SAVE WATER

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Let's do our part!



Signage (Lobbies of many City of Seattle buildings)



Signage (City Hall and Municipal Court fountains)



Signage (Wholesale customer building)



Appendix E – Potential Customer Demand Reduction Actions

Potential Customer Demand Reduction Actions ¹ (See the footnotes to understand how to use this list)									
#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
1	Clothes Washing	Behavior	N/A - Conservation	Indoor	Year Round	NR	Towels On Request: Provide new towels only on request.	No	
2	Clothes Washing	Hardware	N/A - Conservation	Indoor	Year Round	SF & MF	Efficient Clotheswashers: If buying a new clotheswasher, select a water-efficient model. Clotheswashers are the second largest water users in homes.	No	
3	Clothes Washing & Dish Washing	Behavior	N/A - Conservation	Indoor	Year Round	All	Wash Full Loads: Wash only full loads of laundry and dishes.	No	
4	Cooling Towers	Behavior	N/A - Conservation	Indoor	Year Round	NR	Check Cooling Towers: Check cooling towers for overflow and excessive blowdown.	No	
5	Dish Washing	Behavior	N/A - Conservation	Indoor	Year Round	SF & MF	Don't Pre-Rinse Dishes: Don't pre-rinse dishes unless heavily soiled. Most new dishwashers don't require pre-rinsing.	No	
6	Faucets	Behavior	N/A - Conservation	Indoor	Year Round	SF & MF	Turn Off Tap: Turn off the tap while brushing your teeth or shaving.	No	
7	Faucets	Behavior	N/A - Conservation	Indoor	Year Round	All	Minimize Garbage Disposal: Put food waste in your compost bin, rather than using your garbage disposal.	No	
8	Faucets	Behavior	N/A - Conservation	Indoor	Year Round	NR	Thaw in Fridge: Thaw frozen food in the refrigerator, rather than under running water.	No	

Potential Customer Demand Reduction Actions¹

(See the footnotes to understand how to use this list)

#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
9	Faucets	Hardware	N/A - Conservation	Indoor	Year Round	SF & MF	Efficient Faucets: Replace older bathroom faucet aerators with WaterSense models, which use far less water. (Note: There are different flow rates for residential vs non-residential. This is the residential version.)	No	
10	Faucets	Hardware	N/A - Conservation	Indoor	Year Round	NR	Efficient Faucets: Replace older bathroom faucet aerators with newer, more-efficient models that use 0.5/1.0 gallon per minute or less. (Note: There are different flow rates for residential vs non-residential. This is the non-residential version.)	No	
11	Faucets	Behavior	Voluntary	Indoor	Year Round	NR	Water On Request: Serve water only on request, and then ask before refilling.	No	
12	Fire Lines	Behavior	Mandatory	Indoor	Year Round	NR	No Fire Line Testing: Fire line testing within buildings is prohibited. (Note: Confirm w/ Fire Department this is reasonable.)	No	Yes
13	Hose	Behavior	N/A - Conservation	Outdoor	Year Round	All	Use a Broom Not Hose: Use a broom, rather than a hose, to clean sidewalks, driveways, and patios.	No	
14	Hose	Behavior	N/A - Conservation	Outdoor	Year Round	All	Hose Shut-Offs: Never leave a hose running; always use a shut-off nozzle.	No	
15	Hose	Behavior	Mandatory	Outdoor	Year Round	All	No Hose Washing: Using a hose to clean sidewalks, driveways, and patios is prohibited. Use a broom instead.	Yes	Yes

Potential Customer Demand Reduction Actions¹ (See the footnotes to understand how to use this list)									
#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
16	Irrigation - Frequency	Behavior	N/A - Conservation	Outdoor	Summer	All	Water Deeply, But Infrequently: It's better to have one or two deep waterings, rather than several shallow waterings.	No	
17	Irrigation - Frequency	Behavior	Voluntary	Outdoor	Summer	All	Eliminate One Watering Day: Cut one day from your typical weekly watering schedule (except for young trees as noted elsewhere). (Note: The similar "Water X Times A Week Maximum" series might be preferred wording, but this is included as an option.)	No	
18	Irrigation - Frequency	Behavior	Voluntary	Outdoor	Summer	All	Eliminate Two Watering Days: Cut two days from your typical weekly watering schedule (except for young trees as noted elsewhere). (Note: The similar "Water X Times A Week Maximum" series might be preferred wording, but this is included as an option.)	No	
19	Irrigation - Frequency	Behavior	Voluntary	Outdoor	Summer	All	Eliminate Three Watering Days: Cut three days from your typical weekly watering schedule (except for young trees as noted elsewhere). (Note: The similar "Water X Times A Week Maximum" series might be preferred wording, but this is included as an option.)	No	
20	Irrigation - Frequency	Behavior	Voluntary	Outdoor	Summer	All	Water Twice A Week Maximum: Limit plant watering to twice a week.	No	

Potential Customer Demand Reduction Actions¹ (See the footnotes to understand how to use this list)									
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21	Irrigation - Frequency	Behavior	Voluntary	Outdoor	Summer	All	Water Once A Week Maximum: Limit plant watering to once a week (except for young trees as noted elsewhere).	No	
22	Irrigation - Frequency	Behavior	Mandatory	Outdoor	Summer	All	Water Twice A Week Maximum: Plant watering is only allowed twice a week, in accordance with the published schedule by address.	Yes	
23	Irrigation - Frequency	Behavior	Mandatory	Outdoor	Summer	All	Water Once A Week Maximum: Plant watering is only allowed once a week, in accordance with the published schedule by address.	Yes	
24	Irrigation - Method	Behavior	N/A - Conservation	Outdoor	Summer	All	Tune Up Automatic Systems: Do an efficiency tune up of your automatic irrigation system such as fixing overspray onto sidewalks and ensuring sprinkler heads reach adjacent sprinkler heads.	No	
25	Irrigation - Method	Behavior	N/A - Conservation	Outdoor	Summer	All	Get Water to the Roots: Use soaker hoses, drip irrigation, or watering wands to deliver water where it's needed.	No	
26	Irrigation - Method	Behavior	N/A - Conservation	Outdoor	Summer	All	Water Young Trees Efficiently: Water young trees efficiently using a water bag. Trees planted 5 or fewer years ago need 15-20 gallons of water twice a week to thrive.	No	

Potential Customer Demand Reduction Actions¹ (See the footnotes to understand how to use this list)									
#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
27	Irrigation - Method	Behavior	Voluntary	Outdoor	Summer	All	Water Young Trees Efficiently: Water young trees efficiently using a water bag. Trees planted 5 or fewer years ago need 15-20 gallons of water once a week to survive. (Note: This is only appropriate if the maximum temperatures are in the low 70s w/ occasional showers and not peak daylight hours.)	No	
28	Irrigation - Method	Hardware	N/A - Conservation	Outdoor	Summer	All	Upgrade Automatic Systems: Consider efficiency upgrades to your automatic irrigation system such as weather-based or soil-based controllers.	No	
29	Irrigation - Method	Behavior	Mandatory	Outdoor	Summer	All	No Automatic Irrigation: Use of automatic irrigation systems is prohibited. Watering by hand, soaker hose, and/or drip irrigation is allowed.	Yes	Yes
30	Irrigation - Other	Hardware	N/A - Conservation	Outdoor	Summer	All	2 Inches of Mulch: Put 2 inches of mulch on planting beds and around trees, which reduces evaporation. Keep the mulch a hands-width away from the trunk.	No	
31	Irrigation - Other	Behavior	Mandatory	Outdoor	Summer	All	No Irrigation: Irrigation is prohibited.	Yes	Yes
32	Irrigation - Plant Material	Behavior	N/A - Conservation	Outdoor	Summer	All	Mow High: Set your lawn mower blade to cut grass 2 inches high, which reduces evaporation.	No	

Potential Customer Demand Reduction Actions¹ (See the footnotes to understand how to use this list)									
#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
33	Irrigation - Plant Material	Behavior	Voluntary	Outdoor	Summer	SF & MF	Let Lawn Go Dormant: If your lawn isn't already dormant (brown), let it go dormant until the fall rains return. Just water deeply once each month to keep roots alive.	No	
34	Irrigation - Plant Material	Hardware	Voluntary	Outdoor	Summer	All	Plant in Fall: Consider delaying new plantings. Fall is the best time for planting new trees, shrubs and perennials, since rain provides natural irrigation.	No	
35	Irrigation - Plant Material	Behavior	Mandatory	Outdoor	Summer	All	No Lawn Watering: Watering of lawns is prohibited.	Yes	Yes
36	Irrigation - Timing	Behavior	N/A - Conservation	Outdoor	Summer	All	Water Early or Late: Water before 8am or after 7pm, which reduces evaporation.	No	
37	Irrigation - Timing	Behavior	Mandatory	Outdoor	Summer	All	Water Early or Late: Watering between 8am and 7pm is prohibited, due to high evaporation.	Yes	
38	Kitchen	Hardware	N/A - Conservation	Indoor	Year Round	NR	Commercial Kitchen Equipment: If buying new food steamers, dishwashers, or ice machines, select water-efficient models.	No	
39	Leaks	Behavior	N/A - Conservation	Outdoor	Summer	All	Fix Leaks: Check for and fix outdoor leaks, such as at hose bibs, spray heads, valves, and broken pipes.	No	

Potential Customer Demand Reduction Actions¹ (See the footnotes to understand how to use this list)									
#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
40	Leaks	Behavior	N/A - Conservation	Indoor	Year Round	SF & MF	Fix Leaks: Check for and fix indoor leaks, such as at faucets. Also, check your toilets for silent leaks. Put several drops of food coloring in your toilet tank. After 10 minutes, if you have color in the toilet bowl, you have a flapper leak. (Note: For the non-residential sector, specify for "tank" toilets for the toilet check.)	No	
41	Other	Behavior	N/A - Conservation	Indoor	Year Round	NR	Equipment Not in Use: Turn off water-using equipment when not in use, including dishwashers, garbage disposals, and food troughs.	No	
42	Other	Behavior	N/A - Conservation	Both	Year Round	NR	Employee Awareness: Increase employee awareness about using water wisely and encourage their suggestions.	No	
43	Other	Hardware	N/A - Conservation	Indoor	Year Round	NR	Other Water-Using Equipment: Consider upgrading any other water-using equipment to models that are more efficient.	No	
44	Pools & Hot Tubs	Behavior	N/A - Conservation	Outdoor	Year Round	All	Pool & Hot Tub Covers: Use covers on swimming pools and hot tubs when not in use to reduce evaporation.	No	
45	Pools & Hot Tubs	Behavior	Voluntary	Outdoor	Year Round	All	Minimize Filling Pools & Hot Tubs: Minimize refilling swimming pools and hot tubs.	No	
46	Pools & Hot Tubs	Behavior	Mandatory	Outdoor	Year Round	All	No Pools & Hot Tubs: Filling swimming pools and hot tubs is prohibited. (Note: Add a statement about safety around empty pools/tubs.)	Yes	Yes

Potential Customer Demand Reduction Actions¹ (See the footnotes to understand how to use this list)									
#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
47	Pressure Washing	Behavior	Voluntary	Outdoor	Year Round	All	Minimize Pressure Washing: Do only essential pressure washing.	No	
48	Pressure Washing	Behavior	Mandatory	Outdoor	Year Round	All	No Pressure Washing: Pressure washing is prohibited.	Yes	Yes
49	Showers	Hardware	N/A - Conservation	Indoor	Year Round	All	Efficient Showerheads: Replace older showerheads with WaterSense models, which use far less water.	No	
50	Showers	Behavior	Voluntary	Indoor	Year Round	SF & MF	Shorter Showers (a): Reduce your showering time. (Note: This was the "shorter showers" action that was promoted during the 2015 WSCP implementation.)	No	
51	Showers	Behavior	Voluntary	Indoor	Year Round	SF & MF	Shorter Showers (b): Reduce your showering time by one minute.	No	
52	Showers	Behavior	Voluntary	Indoor	Year Round	SF & MF	Shorter Showers (c): Reduce your showering time, by two minutes.	No	
53	Showers	Behavior	Voluntary	Indoor	Year Round	SF & MF	Shorter Showers (d): Limit showers to five minutes or less.	No	
54	Toilets	Hardware	N/A - Conservation	Indoor	Year Round	All	Efficient Toilets: If buying a new toilet, look for a WaterSense or Premium WaterSense model, which use far less water than older models. Toilets are the largest water users in homes. (Note: For the non-residential sector, add urinals.)	No	
55	Toilets	Behavior	Mandatory	Indoor	Year Round	SF & MF	Less Toilet Flushing: Flush your toilet less often. As the saying goes, "If it's yellow, let it mellow." Toilet flushing is the largest water use inside the home.	No	

Potential Customer Demand Reduction Actions¹

(See the footnotes to understand how to use this list)

#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
56	Vehicle Washing	Behavior	N/A - Conservation	Outdoor	Year Round	All	Wash Vehicles Wisely: Wash your vehicle(s) at locations that recycle the water.	No	
57	Vehicle Washing	Behavior	Voluntary	Outdoor	Year Round	All	Minimize Vehicle Washing: Reduce the frequency of, or eliminate, washing vehicles.	No	
58	Vehicle Washing	Behavior	Mandatory	Outdoor	Year Round	All	No Vehicle Washing: Washing of vehicles is prohibited, unless at a location that recycles the water.	Yes	Yes
59	Water Feature	Behavior	Voluntary	Outdoor	Year Round	All	Turn Off Water Features (a): Turn off non-recirculating water features such as fountains.	No	
60	Water Feature	Behavior	Voluntary	Outdoor	Year Round	All	Turn Off Water Features (b): Turn off all water features such as fountains. (Note: This was the "turn off water features" action that was promoted during the 2015 WSCP implementation.)	No	
61	Water Feature	Behavior	Mandatory	Outdoor	Year Round	All	No Water Features (a): Use of non-recirculating decorative water features such as fountains is prohibited.	Yes	
62	Water Feature	Behavior	Mandatory	Outdoor	Year Round	All	No Water Features (b): Use of decorative water features such as fountains is prohibited.	Yes	

1. This is a list of potential actions that customers can take to reduce their water use. The actual actions requested/required for each stage will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed. The list is in Excel, to allow for sorting and filtering, which should help develop the actual list of actions to be implemented. The list is sorted by 1) end use, 2) behavior vs hardware, 3) WSCP stage.
2. The end use is how the water is being used and is typically a type of water-using fixture/equipment (e.g., showers).
3. The requested/required list of actions should include both hardware and behavior actions in order to: 1) increase the demand reduction potential, 2) ensure every customer type has actions they can do, and 3) minimize the cost to participate. For example, since some customers do not have control

Potential Customer Demand Reduction Actions¹

(See the footnotes to understand how to use this list)

#	End Use ²	Behavior vs Hardware ³	WSCP Stage ⁴	Indoor vs Outdoor ⁵	Season ⁶	Sector ⁷	Demand Reduction Action ⁸	Enforce ⁹	Potential Exemption ¹⁰
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over their water-using hardware, it is important to make sure they have behavior actions. Similarly, since behavior actions are typically free, it is important to include many of them.

4. The stage designation is a suggestion, but may be appropriate to change due to circumstances of a particular shortage. Note the following about the stage designations:

- **N/A - Conservation:** None of the actions are designated as Advisory since that stage is internally focused and is not intended to include outreach to customers. However, some actions are identified as Conservation for two reasons. First, if the public/press become aware that SPU has activated the WSCP (at the Advisory Stage level), SPU may be asked to provide suggested customer actions. In that case, the Conservation actions (things SPU recommends continually and do not involve customer sacrifice) would be appropriate. Second, many of the Conservation actions can be promoted in the higher stages since some customers may choose not to follow these recommendations and, thus, while technically conservation actions, can be used as curtailment actions.
- **Voluntary/Mandatory:** The Voluntary and Mandatory actions are true curtailment.
- **Emergency:** No Emergency actions are identified, however they would likely be the Mandatory actions, without most exemptions.

5. The requested/required list of actions should include both indoor and outdoor actions in order to: 1) increase the demand reduction potential, and 2) ensure every customer type has actions they can do. For example, since apartment dwellers won't be able to implement most outdoor actions, it is important to make sure there is a sufficient number of indoor actions for them.

6. The seasonality of the action is important to consider in regards to the timing of the shortage. For example, if the shortage does not occur during the summer, it is unlikely that the Summer actions (mostly irrigation-related) would be useful.

7. SF = single family; MF = multifamily; NR = non-residential (commercial, industrial, institutional). The requested/required list of actions should include options for all sectors in order to: 1) increase the demand reduction potential, and 2) ensure every customer type has actions they can do.

8. The specific language for each measure has been carefully crafted, based on previous implementations of the WSCP. However, the language is still just a suggestion and can be edited for many reasons including length. Note that some end uses have several, similar sounding actions. In some cases, it is to provide options for the team to consider (e.g., the number of days to restrict irrigation to). In other cases, it is to provide actions for several stages (e.g., minimize vehicle washing for voluntary and prohibit vehicle washing in mandatory.)

9. The column indicates whether SPU would likely enforce the action. Enforcement is only applicable to the Mandatory (and the eventual Emergency) actions. Outdoor actions are typically stronger candidates for enforcement, compared to indoor actions, since SPU staff can more readily see outdoor water uses (e.g., irrigation, hose use, car washing, etc.).

10. Some Mandatory (and the eventual Emergency) actions will have exemptions associated with them, such as for irrigation restrictions. This column indicates a potential exemption. See a separate appendix for more details regarding exemptions.

Appendix F – Utility Customer Outreach Checklist

This checklist is intended to be used by every utility that is part of the Seattle Water Supply System (wholesale customers of SPU) during implementation of the Water Shortage Contingency Plan. The checklist differentiates between actions that SPU will perform on behalf of its wholesale customers and actions that each individual utility is responsible for.

Utility Name: _____

Check Box	Customer Outreach Action
SPU Does For the Region	
	Statewide Actions and Messaging: Coordinate with Ecology, Health, and Governor's Office.
	Tri-County Actions and Messaging: Coordinate with Tacoma and Everett, as needed.
	Seattle Water Supply System Actions and Messaging: Lead coordination of the Operating Board and the Conservation Technical Forum.
	Regional Press Release: Issue regional press releases to major media outlets (& conduct subsequent media interviews).
	Regional Traditional Media: Purchase regional traditional media ads such as tv, radio, print, as appropriate.
	Regional Drought Website: Host a website to serve as the main drought website. This would likely be www.savingwater.org , with a link to the SPU Water Supply page.
	Tips Flyer - Create: Create a flyer that helps customers: 1) understand there is a shortage situation and 2) understand ways to reduce their water use.
	Landscaping Community: Outreach to key landscaping community contacts including nurseries (e.g., Molbaks, Sky, Swansons), industry organizations (WALP, WSNLA), the Garden Hotline, and parks/recreation departments. For contacts that are in wholesale customers' service areas, SPU will coordinate the outreach with the appropriate wholesale customer.
Expected By Each Utility	
	Utility Websites: Post drought information prominently on the utility's homepage and link to the regional drought website.
	Tips Flyer - Utilize: Make the tips flyer readily available (e.g., on utility website, in utility lobby, distribute in public areas such as community centers, libraries, etc.).
	Utility Bill / Insert / Newsletter: Include drought messages in existing utility "publications" such as bills, bill inserts, newsletters, etc.
	Social Media: Include drought messages in any social media vehicles used by the utility such as Facebook, twitter, Next Door, etc.

	Signage: Post signage in appropriate locations (e.g., at utility buildings, on utility vehicles, in key locations in service area).
	Brief Staff: Brief utility staff regarding the drought, using the SPU-produced FAQ as one tool.
	Events: Highlight the drought message at any community events the utility is participating in.
Suggested For Each Utility	
	Key Customers: Contact key customers directly (e.g., large water users, significant irrigators, highest billing tier, etc.).
	Local Press Release: Issue press releases to local media outlets (& conduct subsequent media interviews).
	On-Hold Message: Put a drought message to the telephone "on hold" messages for customers.
	Email Signature Line: Add a drought message in the email signature for utility staff.

Appendix G – Potential Exemptions for Water Use Restrictions

This document provides a framework for developing and implementing exemptions to customer water use restrictions that are part of the Mandatory and Emergency stages of the WSCP.

Background

Water use restrictions are key components of the Mandatory and Emergency Stages of the WSCP. For some water use restrictions, exemptions for continued water use may be appropriate. Exemptions can be useful in balancing the need to reduce overall water demand with minimizing hardships imposed on customers and certain industries, as well as protecting health and safety. For example, in the Mandatory stage, SPU may prohibit irrigation for established plants, while allowing irrigation for newly planted landscapes because of their need for water to survive their establishment period.

The importance of exemptions, and effective implementation of them, was learned from the 1992 implementation of the WSCP, which advanced to the Mandatory Stage. Lawn watering was banned and initially there were no clear exemptions. Prohibiting lawn watering is a sensitive issue, and doing so without clear exemptions made the situation even more difficult. Both individual customers and the professional landscaping industry were extremely frustrated. SPU's long-term relationship with the landscape industry, which is important to advancing SPU's water, drainage, and solid waste goals, suffered as a result. One lesson learned from the 1992 drought was to minimize exemptions and to advertise them up front.

As described previously, the WSCP does not pre-identify specific demand reduction actions for each stage. Rather a comprehensive list of potential actions customers can take to reduce water use is provided in Appendix E. The actual actions requested or required for each stage will depend on the severity, likely duration, and timing of the shortage, as well as the demand reduction needed.

Similarly, the exact exemptions for the water use restrictions eventually selected for implementation in the Mandatory and Emergency Stages are not pre-identified. Rather this document provides a framework to be used during each implementation of the WSCP for how to develop and implement the restrictions.

Potential Exemptions

Potential exemptions that should be considered include, but are not limited to, the following:

- **Irrigation (Lines 29, 31 and 35 in Appendix E)**
 - Newly planted landscapes (Will need to define “new” which could be within 12 months, within the calendar year, or something else. For lawns, likely clarify that “new” does not include overseeding. Need to be clear that plantings done after restrictions are announced are not eligible unless done as part of a capital project and necessary for a function purpose such as slope stabilization rather than for aesthetics.)
 - Sports fields (because they contribute to physical and psychological benefits of children and adults, and can be dangerous if not kept watered)
 - Golf course tees and greens (restrictions would apply to the fairways)
 - High traffic turf in parks
 - Trees (because they cannot be quickly or inexpensively replaced)
 - Plant nurseries and garden centers watering plant inventory
 - Food crops
 - Disabled gardeners who cannot hand water (applicable to prohibition of automatic systems; likely do not publicize)
- **Vehicle Washing (Line 58 in Appendix E)**
 - Vehicle washing at a commercial car washing facility. (The default potential restriction for vehicle washing is “washing of vehicles is prohibited, unless at a location that recycles the water”.) This potential exemption is essentially changing that restriction to be “washing of vehicles is prohibited, unless at a commercial facility” and is a recognition that the former might have a significant negative financial impact on car washes that do not recycle the water.
- **Pressure Washing (Line 48 in Appendix E)**
 - Pressure washing necessary to protect public health and safety (not for aesthetic purposes), such as washing downtown parks/sidewalks to clear trash, food, and human waste.
 - Pressure washing that is part of scheduled building rehabilitation, such as preparing a surface for painting.

- **Hose Washing (Line 15 in Appendix E)**
 - Hose washing necessary to protect public health and safety (not for aesthetic purposes), such as washing downtown parks/sidewalks to clear trash, food, and human waste.
- **Swimming Pools and Hot Tubs (Line 46 in Appendix E)**
 - Health care facilities such as hospital physical therapy pools
 - Commercial businesses where swimming pools or hot tubs are central to their business and shutting them down would have a significant negative financial impact.
 - Public swimming and wading pools, since they serve a large number of people and can offset the use of private, personal pools that serve a small number of people.
- **Fire Line Testing (Line 12 in Appendix E)**
 - Testing necessary to protect public health and safety.
- **Private Wells / Reclaimed Water**
 - Any use of water that is not from the public water system but is from private wells or reclaimed water. SPU does not have the authority to restrict use of these sources. SPU could encourage users to post signs to indicate that alternative sources of water are being used.

Development Process

The recommended process to develop and implement the exemptions is as follows:

- Once the water use restrictions have been determined, develop any associated exemptions. The development of the exemptions should include input from the impacted parties. This can be done through the Water Shortage Advisory Group and/or outreach to specific industries such as landscaping, car washing, and building management.
- Decide whether each exemption will require pre-approval by SPU.
- Develop the process and systems necessary for processing exemption requests.
 - Customer contacts SPU
 - Need to determine SPU contact
 - Need to determine submission method (e.g., email, phone, website)

- Need to determine submission contents (e.g., name, address of water use, water account number, description of how they fit the exemption, any required proof)
- Enter request into tracking system
 - Need to develop tracking system (e.g., Excel spreadsheet)
- Determine whether request qualifies or not
 - Need to set criteria to be considered for qualifying exemptions, with some discretion on behalf of SPU (e.g., undue financial hardship, public health and safety, etc.).
 - Need to determine who can authorize exemptions (the primary contact or higher level?)
- Notify customer of result
 - Need to determine notification method (e.g., email, phone, website)
 - Need to determine whether customer will be required to post notice of exemption from SPU.
- Publicize the exemptions and the process to request an exemption when the restrictions are announced, including noting that exemptions may be revoked if the water supply situation worsens.

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

APPENDIX B

WATER SYSTEM INVENTORIES

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-1
Water Facilities Inventory Form

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WATER FACILITIES INVENTORY (WFI) FORM

ONE FORM PER SYSTEM

Quarter: 1

Updated: 01/22/2018

Printed: 2/28/2018

WFI Printed For: On-Demand

Submission Reason: Pop/Connect Update

RETURN TO: Central Services - WFI, PO Box 47822, Olympia, WA, 98504-7822

1. SYSTEM ID NO. 77050 Y	2. SYSTEM NAME SEATTLE PUBLIC UTILITIES	3. COUNTY KING	4. GROUP A	5. TYPE Comm
6. PRIMARY CONTACT NAME & MAILING ADDRESS WYLIE V. HARPER [WQ QA DIRECTOR] SEATTLE PUBLIC UTILITIES/WQ LAB 800 S STACEY ST SEATTLE, WA 98134		7. OWNER NAME & MAILING ADDRESS SEATTLE, CITY OF RICKY A. SCOTT PO BOX 34018 SEATTLE, WA 98124-4018		8. OWNER NUMBER: 005246
STREET ADDRESS IF DIFFERENT FROM ABOVE ATTN ADDRESS CITY STATE ZIP		STREET ADDRESS IF DIFFERENT FROM ABOVE ATTN ADDRESS 700 5TH AVE # 4900 CITY SEATTLE STATE WA ZIP 98124		
9. 24 HOUR PRIMARY CONTACT INFORMATION Primary Contact Daytime Phone: (206) 684-7880 Primary Contact Mobile/Cell Phone: (206) 790-5669 Primary Contact Evening Phone: (xxx)-xxx-xxxx Fax: E-mail: xxxxxxxxxxxxxxxxxxxx		10. OWNER CONTACT INFORMATION Owner Daytime Phone: (206) 684-7414 Owner Mobile/Cell Phone: Owner Evening Phone: Fax: E-mail: xxxxxxxxxxxxxxxxxxxx		
WAC 246-290-420(9) requires that water systems provide 24-hour contact information for emergencies.				
11. SATELLITE MANAGEMENT AGENCY - SMA (check only one) ☒ Not applicable (Skip to #12) ☐ Owned and Managed SMA NAME: SMA Number: ☐ Managed Only ☐ Owned Only				
12. WATER SYSTEM CHARACTERISTICS (mark all that apply) ☐ Agricultural ☒ Hospital/Clinic ☒ Residential ☒ Commercial / Business ☒ Industrial ☒ School ☒ Day Care ☒ Licensed Residential Facility ☐ Temporary Farm Worker ☒ Food Service/Food Permit ☒ Lodging ☐ Other (church, fire station, etc.): ☐ 1,000 or more person event for 2 or more days per year ☒ Recreational / RV Park				
13. WATER SYSTEM OWNERSHIP (mark only one) ☐ Association ☐ County ☐ Investor ☐ Special District ☒ City / Town ☐ Federal ☐ Private ☐ State				14. STORAGE CAPACITY (gallons) 398,000,000

- SEE NEXT PAGE FOR A COMPLETE LIST OF SOURCES -

WATER FACILITIES INVENTORY (WFI) FORM - Continued

1. SYSTEM ID NO. 77050 Y		2. SYSTEM NAME SEATTLE PUBLIC UTILITIES										3. COUNTY KING										4. GROUP A		5. TYPE Comm	
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15	16 SOURCE NAME	17 INTERTIE	18 SOURCE CATEGORY										19 USE	20	21 TREATMENT					22 DEPTH	23	24 SOURCE LOCATION						
Source Number	LIST UTILITY'S NAME FOR SOURCE AND WELL TAG ID NUMBER. Example: WELL #1 XYZ456 IF SOURCE IS PURCHASED OR INTERTIED, LIST SELLER'S NAME Example: SEATTLE	INTERTIE SYSTEM ID NUMBER	WELL	WELL FIELD	WELL IN A WELL FIELD	SPRING	SPRING FIELD	SPRING IN SPRINGFIELD	SEA WATER	SURFACE WATER	RANNEY / INF. GALLERY	OTHER	PERMANENT	SEASONAL	EMERGENCY	SOURCE METERED	NONE	CHLORINATION	FILTRATION	FLUORIDATION	IRRADIATION (UV)	OTHER	DEPTH TO FIRST OPEN INTERVAL IN FEET	CAPACITY (GALLONS PER MINUTE)	1/4, 1/4 SECTION	SECTION NUMBER	TOWNSHIP	RANGE
			S01	CEDAR RIVER									X			X			Y		X	X	X			125000	SW SE	19
S02	TOLT RIVER									X			X			Y		X	X	X			83280	NW SW	32	26N	09E	
S03	RIVERTON HTS #1				X								X		Y		X	X				275	3200	NE NW	21	23N	04E	
S04	BOULEVARD		X										X		Y		X	X				293	2000	NW NW	16	23N	04E	
S05	RIVERTON HTS #2				X								X		Y		X	X				280	1800	NE NW	21	23N	04E	
S06	RIVERTON HTS WF			X									X		Y		X	X				5000		NE NW	21	23N	04E	
S07	RENTON/71850	71850 L													X	Y					X		3800			00N	00E	

WATER FACILITIES INVENTORY (WFI) FORM - Continued

1. SYSTEM ID NO. 77050 Y	2. SYSTEM NAME SEATTLE PUBLIC UTILITIES	3. COUNTY KING	4. GROUP A	5. TYPE Comm
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	ACTIVE SERVICE CONNECTIONS	DOH USE ONLY CALCULATED ACTIVE CONNECTIONS	DOH USE ONLY APPROVED CONNECTIONS
25. SINGLE FAMILY RESIDENCES (How many of the following do you have?)		160347	Unspecified
A. Full Time Single Family Residences (Occupied 180 days or more per year)	160347		
B. Part Time Single Family Residences (Occupied less than 180 days per year)	0		
26. MULTI-FAMILY RESIDENTIAL BUILDINGS (How many of the following do you have?)			
A. Apartment Buildings, condos, duplexes, barracks, dorms	13305		
B. Full Time Residential Units in the Apartments, Condos, Duplexes, Dorms that are occupied more than 180 days/year	0		
C. Part Time Residential Units in the Apartments, Condos, Duplexes, Dorms that are occupied less than 180 days/year	0		
27. NON-RESIDENTIAL CONNECTIONS (How many of the following do you have?)			
A. Recreational Services and/or Transient Accommodations (Campsites, RV sites, hotel/motel/overnight units)	0	0	
B. Institutional, Commercial/Business, School, Day Care, Industrial Services, etc.	13486	13486	
28. TOTAL SERVICE CONNECTIONS		173833	

29. FULL-TIME RESIDENTIAL POPULATION
A. How many residents are served by this system 180 or more days per year? <u>743796</u>

30. PART-TIME RESIDENTIAL POPULATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many part-time residents are present each month?												
B. How many days per month are they present?												

31. TEMPORARY & TRANSIENT USERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many total visitors, attendees, travelers, campers, patients or customers have access to the water system each month?												
B. How many days per month is water accessible to the public?												

32. REGULAR NON-RESIDENTIAL USERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. If you have schools, daycares, or businesses connected to your water system, how many students daycare children and/or employees are present each month?	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000
B. How many days per month are they present?	31	28	31	30	31	30	31	31	30	31	30	31

33. ROUTINE COLIFORM SCHEDULE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
* Requirement is exception from WAC 246-290	270	270	270	270	270	270	270	270	270	270	270	270

34. NITRATE SCHEDULE	QUARTERLY	ANNUALLY	ONCE EVERY 3 YEARS
(One Sample per source by time period)			

35. Reason for Submitting WFI:

☐ Update - Change
 ☐ Update - No Change
 ☐ Inactivate
 ☐ Re-Activate
 ☐ Name Change
 ☐ New System
 ☐ Other _____

36. I certify that the information stated on this WFI form is correct to the best of my knowledge.	
SIGNATURE: _____	DATE: _____
PRINT NAME: _____	TITLE: _____

<u>WS ID</u>	<u>WS Name</u>
77050	SEATTLE PUBLIC UTILITIES

Total WFI Printed: 1

SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-2
Water System Management and Operator Certification

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Water System Management and Operator Certification

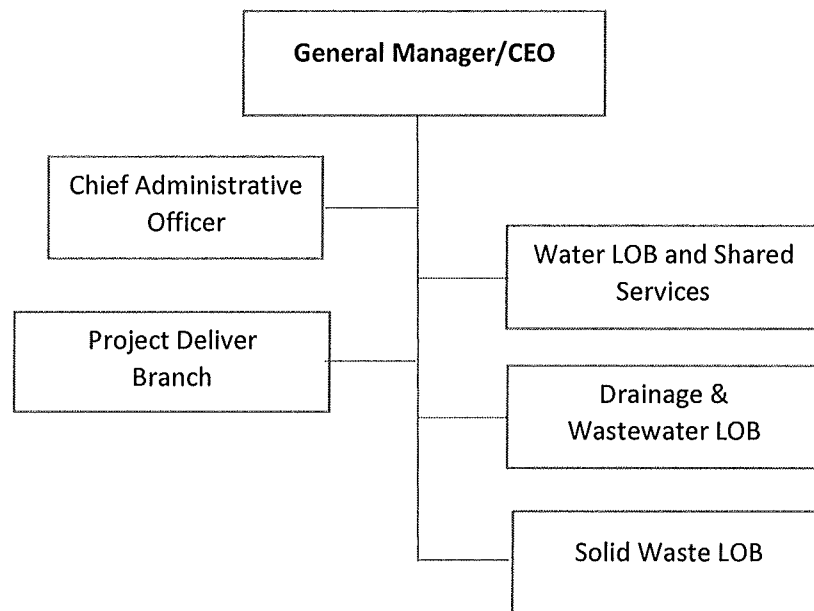
February 2018

Seattle Public Utilities (SPU) reorganized its organizational structure since the *2013 Water System Plan*. Of note is consolidation of information technology and human resource functions into centralized City of Seattle departments. Also, the branch structure was realigned to correspond to Lines of Business (LOBs): Water, Solid Waste, and Drainage & Wastewater.

An explanation of the management structure and personnel at SPU is provided here, followed by a description of SPU's current operator certifications and training programs. Also included is a description of SPU's apprenticeship program to train new recruits.

Management and Organizational Structure

An organizational chart for SPU, which shows the current departmental structure, is provided below. A brief explanation of the role of the General Manager/Chief Executive Officer, Chief Administrative Officer, and each SPU branch is provided below.



Seattle Public Utilities Organizational Structure

General Manager/Chief Executive Officer

The General Manager and Chief Executive Officer (GM/CEO) is responsible for making sure the utility carries out the mission adopted for SPU. The GM/CEO has responsibilities typical of a water superintendent, such as developing budgetary requirements, assuring effective performance of the water system, and implementing City ordinances and utility policies regarding water service.

Chief Administrative Officer

The Chief Administrative Officer has responsibility over the following functions that support all the lines of business:

- Finance and Administration
- Customer Service
- Office of Utility Services¹
- Communications
- Environmental Justice and Social Equity
- Human Resources
- Corporate Policy and Intergovernmental Relations

Project Delivery Branch

The Project Delivery Branch (PDB) provides a variety of engineering and engineering support services to clients within and outside of SPU. PDB provides project management, engineering, design, survey, drafting, basemapping, construction specification and contract preparation, project cost estimating, geotechnical, materials testing, construction inspection, and contract payment services. Registered professional engineers and land surveyors reside in this Branch, as well as elsewhere in SPU. PDB executes SPU capital projects from start to completion, and provides specific services as appropriate on projects developed by other City departments, other agencies, and developers. PDB applies asset management principles and practices to achieve the triple bottom line goals of customer satisfaction, environmental protection/enhancement and cost efficiency. The Development Services Office is located within PDB and provides assistance and approvals for new utility services.

Water Line of Business and Shared Services Branch

The Water LOB branch is responsible for planning, operations and maintenance of all assets associated with the water utility. Divisions within the branch include Water Planning & Program Management, Watershed Management, Drinking Water Quality and Water Operations & System Maintenance. The Water Quality Division operates the state certified laboratory and includes several water quality inspector positions which have Backflow Assembly Tester (BAT), and Cross Connection Control Specialist (CCS) certification. The Shared Services Division supports multiple LOBs and includes maintenance, SCADA support and systems operations.

Drainage & Wastewater LOB and Solid Waste LOB

These two branches provide services analogous to the Water LOB for the other two lines of business within SPU.

Operations Planning and Scheduling (OPS)

SPU's regional water supply system has multiple objectives that must be met and operational risks that must be actively managed:

- water resource management for people and for fish
- water quality source to tap

¹ Provides climate resiliency, environmental review, asset management and economic services.

- pressure and flow in the transmission and distribution system
- system outages – called ‘clearances’ - for construction and major maintenance
- flood management and hydropower generation

In 2008, SPU established an Operations Planning and Scheduling (OPS) function that is supported by a core team. The OPS core team membership consists of:

- OPS Team Lead (as assigned)
- System Control Center Manager
- System Control Center Supervisor
- Clearance Work Order Process and Transmission and Distribution Operations representative
- Water Resources/River and Reservoir Operations representative
- Transmission and Distribution Business Areas representative(s)
- Water Quality and Treatment Business Area representative(s)

The OPS Team meets each week to establish a weekly web-based Water System Operating Plan (WSOP). OPS is responsible for developing, deconflicting and communicating (via the WSOP) the plan and schedule for operation of the water system to meet all of the objectives for the regional water system. OPS also reviews, approves, and schedules construction and major maintenance (‘clearances’) that affect system operations, as well as maintains a schedule of clearances (received, approved and scheduled, in-progress).

The System Control Center, which operates 24/7, is responsible for operating the regional water system according to the WSOP, using best judgment where there are no specific instructions and responding to unusual and emergency situations. In addition, the System Control manages the configuration of the system, detects and directs response to water system emergencies, and coordinates and approves all construction and maintenance activities that require access to water system facilities (headworks, treatment, pump stations, gate houses, etc) or that may have an impact on water system.

Operator Certification

SPU is committed to meeting the requirements of the Water Works Operator Certification Program administered by the Washington State Department of Health (DOH) in conjunction with the Water and Wastewater Operator Certification Board of Examiners under the authority of Chapter 70.119 RCW and the comprehensive program regulations contained in Chapter 246-292 WAC. Under this program, water systems must employ certified operators to carry out various water system functions as part of treatment and distribution systems.

Certification Requirements

SPU is classified as a “Group A” public water system. The Group A classification requires that SPU have certified operators in charge of all active, daily, and technical operations of the water system. In meeting this requirement, SPU maintains certified personnel throughout the utility for a variety of water system operations. This

certification includes water treatment plant operators at the Tolt and Cedar Water Treatment Facilities, which are operated and maintained by private entities under contract by SPU. Required Classifications include Water Distribution Manager (WDM) Levels 3 and 4, Water Treatment Plant Operator (WTPO) Levels 3 and 4, and Cross Connection Control Specialists (CCS) depending on the requirements of specific positions. Table 1 shows the current listing of mandatory water works operator positions and required certification levels for SPU as they relate to the organizational structure of the utility. This list is updated on an annual basis for utility staff and submitted to DOH for their review. Additionally, SPU also has internal SPU certification requirements for lower level positions (involving level 1, and 2 certifications), that are not detailed out here.

Table 1
Mandatory Waterworks Personnel Certifications

Branch	Division	Position	Required Certification
Water LOB and Shared Services	Drinking Water Quality	Drinking Water Director	WDM 4
		Utility Service Inspection Manager	WDM 3, CCS
	Utility Operations & Maintenance	Water Maintenance Manager	WDM 3
		Water Supply Operations Manager	WDM 3
		Water System Supervisor	WDM 3
	Water Operations & System Maintenance	Water Transmission and Distribution Director	WDM 4
		Water Transmission Manager	WDM 3
		Water Pipe Distribution Manager - North End	WDM 3
		Water Pipe Distribution Manager - South End	WDM 3
		Water Pipe Distribution Manager -All City	WDM 3
External Contractors	Contract Treatment Operations	Tolt Facility Manager	WTPO 4
		Tolt Chief Operator	WTPO 3
		Tolt Operator (multiple positions)	WTPO 3
		Cedar Facility Manager	WTPO 4
		Cedar Operations Supervisor	WTPO 3
		Cedar Operator (multiple positions)	WTPO 3

Certified operators are either on-site or on call for all critical water system operations. SPU also ensures that certified operators are in charge of all segments of the water system as appropriate. Certified operators staff the Control Center, and the two primary water treatment plants, 24 hours a day. Also, water system operations and pipe district managers for the Water Operations & System Maintenance Division of SPU's Water LOB Branch maintain necessary Water Distribution Manager certifications.

Training

All certified personnel for SPU renew their certificates on an annual basis and enhance their professional growth in the field by accumulating at least three college-related credits or continuing education units (CEUs) every three years. Personnel meet the CEU requirements through a combination of external and internal training opportunities. External opportunities include State-sponsored classes through the Washington Environmental Training Resource Center (WETRC). Examples of classes offered

through this program include “Chlorination System Operation and Maintenance” and “Basic Electrical.” Internally, SPU takes advantage of a wealth of expertise from a variety of professional staff to offer CEU approved classes. Examples of classes offered through this internal training include:

- National Incident Management System (NIMS)
- Cross Connection Control
- Operations Math
- Corrosion Protection
- Watermain Installation and Print Reading
- Successful Watermain Shutdowns

Apprenticeship Program

As budget has allowed, SPU has provided on-the-job training through its two-year Apprenticeship Programs. The purpose of SPU’s Apprenticeship Program is to develop and continually improve its field talent, while being prepared to meet the increasingly complex and heavily regulated utility staffing needs of the future. The program recruits, hires, and trains apprentices in the Water and Drainage and Wastewater (DWW) lines of business. SPU’s goal is to hire up to 12-15 candidates each for Water & DWW for a total of 24-30 in each class. Beginning in 2020, the program also plans to expand journey-level training and skill development to improve effectiveness, efficiency, and career progression opportunities in existing field staff.

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-3
Water Treatment Chemicals

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Water Treatment Chemicals 2017

Facility	Chemical
Tolt Water Treatment Facility	Liquid Oxygen
	Carbon Dioxide
	Chlorine
	Ferric Chloride
	Hydrofluorosilicic Acid
	Lime
	Cationic Polymer
	Anionic Polymer
	Sodium Bisulfite (has not been used)
	Sodium Hydroxide
Cedar Water Treatment Facility	Liquid Oxygen
	Chlorine
	Lime
	Sodium Bisulfite
Landsburg Diversion & Pre-Treatment Facility	Sodium Hypochlorite
	Hydrofluorosilicic Acid
Seattle Wells*	Sodium Hypochlorite
	Sodium Hydroxide
	Hydrofluorosilicic Acid
In-Town Reservoir Treatment Facilities	Sodium Hypochlorite
	Salt (used for on-site hypochlorite generation)

Notes:

* Indicates the facilities are only used seasonally during the high demand period. Chemicals may not be stored on site during the off season.

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-4
Asset Inventories

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Table 1 Tolt Water Treatment Facility Design Parameters	
Type:	Direct Filtration with Raw Water Ozonation
Capacity:	120 mgd
Ozone Generation	
Type:	LOX Feed
Number of units:	Two duty, one standby
Capacity:	2,388 lbs/day each
Applied dose:	2.9 mg/l (average) 4.8 mg/l (maximum)
Production	1,651 lbs/day (average) 4,775 lbs/day (maximum)
Ozone Contacting	
Type:	Fine bubble diffusion w/baffled contactor
Number of units:	Two parallel trains
Capacity:	60 mgd each
Contact time:	31.6 minutes (theoretical)
Flocculation	
Type:	Hydraulic flocculation w/baffled serpentine flow Pumped jet flash mix for chemical addition
Number of units:	Two parallel trains
Capacity:	60 mgd each
Detention time:	26.5 minutes (theoretical)
Filtration	
Type:	Anthracite mono-medium, with air/water backwash
Number of units:	Six (each with two bays)
Capacity:	24 mgd each
Rate:	12 gpm/sq ft
Bed depth:	72 inches
Clearwell	
Type:	Baffled concrete, cast-in-place
Number of units:	One (two equal halves)
Total volume:	7.4 MG
Washwater Recovery	
Type:	Settling/drying basins
Number of units:	Four
Capacity:	1.385 MG each
FTW/Equalization Basin	
Volume:	1.485 MG
Treatment Chemicals	
Ferric chloride:	Primary coagulant
Cationic polymer:	Primary coagulant/coagulant aid
Anionic/nonionic polymer:	Filter aid and washwater solids settling aid
Gaseous chlorine:	Disinfectant residual
Carbon dioxide:	pH and alkalinity adjustment
Lime:	pH and alkalinity adjustment
Hydrofluosilicic acid:	Fluoride addition
Sodium bisulfite:	Excess ozone quenching

Source: Process Design Criteria (February 2001), CDM PHILIP, SPU updated in 2006 and 2011

Notes:

FTW = Filter to Waste

gpm/sq ft = gallons per minute per square foot

lbs/day = pounds per day

LOX = Liquid Oxygen

mgd = million gallons per day

mg/L = milligrams per liter

MG = million gallons

Table 2 Cedar Water Treatment Facility Design Parameters	
Landsburg	
Chlorination	
System	Chlorine Gas
Goal	Minimize entry of nuisance and invasive species at Lake Youngs
Fluoridation	
System	Hydrofluosilicic Acid
Target Residual	0.8 mg/L
Lake Youngs	
Plant	
Type:	Raw Water Ozonation and Ultra Violet Disinfection
Capacity:	180 mgd
Intake and Raw Water Pump Station	
Pump type	Submersible
Number of units:	7
Size	2 @ 20 mgd, 5 @ 40 mgd
Ozone Generation	
Type:	LOX Feed
Number of units:	2
Design concentration of ozone	6 - 12 %
Capacity:	825 lbs/day @ 12 % each (nominal) 1250 lbs/day @ 6 % each (peak)
Applied ozone dose	0.3 - 0.6 mg/L (typical) 0.8 mg/L (peak)
Ozone Contacting	
Type:	Fine bubble diffusion
Flow direction	Counter-current
Contactor type	Pipeline
Number of units:	Two parallel trains
Volume	0.61 MG
Contact time:	9.8 min @ peak capacity
Ultra Violet Disinfection	
Design basis	3-log Cryptosporidium
Method	Medium pressure
Dosage	40 mJ/sq cm
Contactor type	Closed vessel
Number	13 total
Capacity:	18.4 MGD each
Clearwell	
Type:	Pre-stressed Concrete
Number of units:	2
Total volume:	20 MG
Treatment Chemicals	
Gaseous chlorine:	Disinfectant residual
Lime:	pH and alkalinity adjustment
Sodium Bisulfate	Excess ozone quenching

Source: Design Criteria (Updated July 12, 2004), CH2MHILL; SPU updated in 2006 and 2011

Notes:

lbs/day = pounds per day

min = minutes

LOX = Liquid Oxygen

mJ/sq cm = millijoules per square centimeter

mgd = million gallons per day

mg/L = milligrams per liter

MG = million gallons

Table 3 Seattle Well Fields Treatment Facilities		
Disinfection	System	Sodium Hypochlorite
	Target Dosage	1.0 to 1.4 mg/L
Fluoridation	System	Hydrofluosilicic Acid
	Target Dosage	0.8 mg/L fluoride*
Corrosion Control	System	NaOH Addition
	Target pH	8.2

* Historically, fluoride dose has been 1.0 mg/L. Reduction made in early 2011.

Source: Updated by SPU in October 2011

Table 4 Reservoir and Well Chlorination Facilities					
	Year ^a Chlorination Facility Constructed	Type of Chlorination	Target Chlorine Residual (mg/l)	Redundancy	Condition
Outlet (Primary) Disinfection					
Roosevelt Reservoir	1996	Sodium Hypochlorite	1.1 - 1.3	One main storage tank, one day tank, and peristaltic pumps for sodium hypochlorite injection.	Treatment equipment is in good condition.
Volunteer Reservoir	1954	Chlorine gas 150-lb cylinders	1.2 - 1.3	Has one chlorinator and no sodium hypochlorite injection equipment or storage tanks.	Treatment equipment is in good condition.
Residual Maintenance (Secondary) Disinfection					
Beacon Reservoir	1987	Sodium Hypochlorite	1.0- 1.2	Two peristaltic pumps. Only one main storage tank.	Upgraded in 2000. Began operation as covered reservoir in 2009.
Bitter Lake Reservoir	2001	On-site Hypochlorite Generation	0.9	Backup pumps available. Can add sodium hypochlorite as a back up method.	Treatment equipment is in good condition.
Boulevard Park Well	1987	Sodium Hypochlorite	1.0 - 1.4	Backup pumps available. Well can be shut down if a disinfection equipment failure occurs.	Treatment equipment is in good condition.
Eastside Reservoir	1987	Sodium Hypochlorite	0.8	Backup pumps available. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good shape.
Lake Forest Park Reservoir	2002	On-site Hypochlorite Generation	0.9 - 1.1	Two peristaltic pumps. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good shape.
Lincoln Reservoir	2004	On-site Hypochlorite Generation	1.0 - 1.3	Two peristaltic pumps. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good condition.
Maple Leaf Reservoir	1996	Sodium Hypochlorite	1.0 - 1.3	One main storage tank, one day tank, and peristaltic pumps for sodium hypochlorite injection.	Reservoir is out of service for reconstruction (covering). Treatment equipment is in good condition.
Myrtle Reservoir	2007	On-site Hypochlorite Generation	0.9 - 1.0	Two peristaltic pumps. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good shape. Began operation as covered reservoir in 2008.
Magnolia Reservoir	1994	Sodium Hypochlorite	0.8 - 1.0	Two storage tanks and two metering pumps.	Condition of the equipment is good.
Riverton Well	1987	Sodium Hypochlorite	1.0 - 1.4	Backup pumps available. Well can be shut down if a disinfection equipment failure occurs.	Condition of the equipment is good.
West Seattle Reservoir; Inlet/Outlet and Trenton Outlet	1998	Sodium Hypochlorite	1.0 - 1.2	One main storage tank, one day tank, and peristaltic pumps for sodium hypochlorite injection.	Treatment equipment is in good condition.

Source: Reimer, 1999; Capron, 2011; Green, 2011; Nilson 2011

a In some cases, the year constructed is approximate. Some facilities have had equipment upgrades.

Pipeline Name	Material Type	Largest Diameter (inches)	Length (feet)
430 Pipeline	Cast Iron	30	178
	Concrete Cylinder	42	1,849
	Steel	42	22,643
550 Pipeline	Steel	72	41,006
8th Ave S Pipeline	Concrete Cylinder	24	4,462
Bel Red Road	Concrete Cylinder	24	2,718
	Steel	12	30
Cedar East Side Supply Line	Cast Iron	36	134
	Concrete Cylinder	36	53,499
	Steel	72	637
Cedar River Pipeline 1	Steel	72	85,796
Cedar River Pipeline 2	Concrete Cylinder	51	10,053
	Ductile Iron	52	11
	Steel	60	71,235
Cedar River Pipeline 3	Ductile Iron	48	38
	Steel	72	86,749
Cedar River Pipeline 4	Concrete Cylinder	60	3,428
	Reinforced Concrete	72	31,687
	Steel	72	18,530
Contactor Pipe Line 4	Steel	78	3,675
Contactor Pipe Line 5	Steel	78	3,730
Des Moines Pipeline	Cast Iron	20	14
	Concrete Cylinder	24	18,197
Finished Pipeline 4	Steel	78	13,720
Finished Pipeline 5	Cast Iron	24	17
	Concrete	84	333
	Steel	78	2,991
Lake Youngs Bypass 4	Steel	78	3,006
Lake Youngs Bypass 5	Steel	78	2,999
Lake Youngs Supply Line 4	Steel	92	35,712
Lake Youngs Supply Line 5	Steel	78	35,612
Lake Youngs Tunnel	Concrete	96	11,302
	Steel	96	6
Lake Youngs Tunnel Connection	Cast Iron	24	6
	Steel	72	233
Landsburg Tunnel	Concrete	96	10,129
Maple Leaf Pipeline	Steel	54	26,164
Mercer Island Pipeline	Cast Iron	20	1,384
	Concrete Cylinder	30	9,659
	Steel	30	5,094
	Unknown	20	21
NE 24th St	Cast Iron	16	2,273
NE 8th Pl	Concrete Cylinder	24	3,783
	Ductile Iron	24	174
	Steel	20	30
Olive St Pipeline	Cast Iron	30	2,055
	Concrete Cylinder	36	337
	Ductile Iron	30	374
Ozonation Overflow Line	Steel	54	875
Reg Basin Bypass	Concrete Cylinder	66	3,026
	Steel	66	6
S 146th St Pipeline	Concrete Cylinder	30	5,209
	Ductile Iron	30	32
	Steel	24	65
S 154th St Pipeline	Ductile Iron	36	6,203
	Steel	36	13
Soos Reservoirs 640 Zone	Cast Iron	14	5,470
	Ductile Iron	24	16,555
	Steel	48	1,785
South Fork Tolt Pipeline	Concrete	72	841
	Steel	72	25,820
Tolt East Side Supply Line	Concrete Cylinder	48	52,557
	Steel	54	1,221
	Unknown	16	8
Tolt East Side Supply Line Extension	Concrete Cylinder	48	7,657
	Ductile Iron	24	614
	Steel	48	5,441
Tolt Pipeline 1	Concrete Cylinder	66	56,300
	Ductile Iron	54	17,769
	Steel	81	54,379
Tolt Pipeline 2 Ph I	Steel	60	12,302
Tolt Pipeline 2 Ph II	Steel	60	21,498
Tolt Pipeline 2 Ph III	Steel	81	20,950
Tolt Pipeline 2 Ph IV	Steel	60	32,127
Tolt Pipeline 2 Ph VIa	Steel	87	8,598
Tolt Tietline	Steel	44	7,913
Tolt Treatment Facility Inlet	Steel	90	2,711
Transmission Connection	Steel	60	1
West Seattle Pipeline	Steel	54	25,591
Total		96	1,021,247

Source: Mantchev, 2012, based on SPU GIS

Pipeline lengths are from Arc Ingh field, and include both raw and treated water pipelines.

Excludes all pipelines in the Northwest Subregional System and some pipelines in the Southwest Subregional System which are also Seattle distribution mains.

Table 6 Treated Water Reservoirs						
Reservoir	Year Constructed	Total Capacity (MG)	Number of Cells	Overflow Elev. (feet) ^a	Under- Drain	Construction Type
Regional and Sub-Regional Reservoirs - Covered						
Eastside	1989/90	31.9	1	560	Yes	Reinforced concrete tank. Below grade.
Lake Forest Park	1961/62	60	2	550	Yes	Hyplon-lined, reinforced concrete slab. Floating cover added in 2003.
Maple Leaf	2012	61.06	2	430	Yes	Reinforced concrete tank. Below grade.
Riverton Heights	1979/80	20.1	1	460	Yes	Reinforced concrete tank. Part below grade.
Soos North	1989/90	6.5	1	640	Yes	Reinforced concrete tank. Above grade.
Soos South	1989/90	6.5	1	640	Yes	Reinforced concrete tank. Above grade.
West Seattle	2010	29.21	1	440	Yes	Reinforced concrete tank. Below grade.
Distribution System Reservoirs - Covered						
Bitter Lake	1956/57	21.3	1	509	Yes	Reinforced concrete slab. Hypolon liner and floating cover added in 2001.
Beacon	2009	48.12	1	326	Yes	Reinforced concrete reservoir. Below grade.
Lincoln	2006	12.7	1	326	Yes	Reinforced concrete reservoir. Below grade.
Magnolia	1993/94	5.5	1	330	Yes	Reinforced concrete tank. Part below grade.
Myrtle	2008	4.86	1	498	Yes	Reinforced concrete reservoir. Below grade.
View Ridge	1977/78	2.5	1	276	Yes	Reinforced concrete tank. Below grade.
Distribution System Reservoirs - Open - Out-of-Service^b						
Roosevelt	1910	50.3	1	326	Yes	Unreinforced concrete slab. HDPE liner.
Volunteer	1901	20.5	1	430	No	Unreinforced concrete slab.

Updated 2018

a Nominal elevation based on North American Vertical Datum (NAVD 88).

b Roosevelt and Volunteer Reservoirs were removed from service on April 1, 2013, following the completion of the new buried Maple Leaf Reservoir. The need to retain emergency storage at these locations is being evaluated as part of SPU's water system seismic study that is currently underway. That analysis may indicate the need to keep these uncovered reservoirs for emergency storage, which would entail a different set of design and operations and maintenance considerations compared to the potable reservoirs in service. In the future, these reservoirs may be needed as potable water storage, in which case they would be covered.

**Table 7
Standpipes and Elevated Tanks**

	Year Const.	Capacity (MG)	Base Elev. (feet) ^a	Overflow Elev. (feet) ^b	Diameter (feet)	Tank Height on Riser (feet)	Tank Material	Date of Last Inspection	Interior Coating		Exterior Coating		Seismic Upgrade (or Date Scheduled)
									Type ^c	Date Applied	Type ^e	Date Applied	
Regional and Sub-Regional System													
Standpipes													
Foy ^{f,g}	1933	1.0	495	590	46	-	Riveted Steel	Aug 16	Vinyl	1980	Lead base	2017	To be determined
Elevated Tanks													
Beverly Park	1959	2.0	460	585	105	35	Welded Steel	Apr 15	CTE/epoxy ^h	1985	Zn/Alkyd ^h	1985	To be determined
Myrtle #2	1946	1.0	506.5	585	84.25	NA	Riveted Steel	Nov 17	epoxy	2010	polyurethane	2010	2003
Richmond Highlands #1 ^f	1954	1.0	492.5	590	86	25	Welded Steel	Nov-99	CTE	1954	Lead base	1981	1995
Richmond Highlands #2	1958	2.0	488.5	590	101	35	Welded Steel	Aug 12	polyurethane	2012	polyurethane ⁱ	2012	1995
Others													
Control Works NE Tank	1925	0.3	437	512	NA	-	Riveted Steel	Oct 97	polyurethane	1994	epoxy/urethane ^j	1994	1994 ^d
Control Works SW Tank	1925	0.3	437	512	NA	-	Riveted Steel	Nov 97	polyurethane	1994	epoxy/urethane ^j	1994	1994 ^d
Distribution System													
Standpipes													
Charlestown	1996	1.3	424	498	58	-	Welded Steel	Feb 99	epoxy	1996	epoxy/urethane	1996	To be determined
Queen Anne	2008	1.9	460	530	75	-	Welded Steel	May 17	epoxy	2007	urethane / epoxy / acrylic polyurethane ^k	2007	Not needed
North Trenton	1932	1.2	296	330	92	-	Riveted Steel	Jul 16	Vinyl	1979	Lead base ^l	1990	To be determined
South Trenton	1932	1.2	296	330	92	-	Riveted Steel	Jul 16	Vinyl	1979	Lead base ^l	1990	To be determined
Volunteer Park	1907	0.9	460	530	50	-	Masonry/Riveted Steel	Mar 17	Vinyl	1981	Lead base	1981	To be determined
Elevated Tanks													
Magnolia Bluff	1947	1.0	369	480	86	25	Welded Steel	Apr 16	epoxy	1988	Zn/Alkyd ^{m,n}	1988	1993 ^d

Updated 1/9/2018

a Top of concrete base, based on North American Vertical Datum (NAVD 88).

b Nominal elevation based on North American Vertical Datum (NAVD 88).

c CTE = Coal Tar Enamel; p-urethane = Monolithic polyurethane lining

d May need additional seismic upgrades.

e epoxy = NSF epoxy primer and intermediate coats; and a polyurethane top coat; Zn/Alkyd = Zinc yellow primer and silicone alkyd enamel top coat.

f WDOH has approved decommissioning pending activation of remote starting capability of Bitter Lake Pump Station diesel.

g Foy Standpipe was evaluated for decommissioning, but near term plans are for tank to remain in service.

h Scheduled for internal and external recoating in 2019-20.

i 1993 seismic upgrade added all new steel to legs and riser, and coated legs and riser with a non-lead alkyd enamel paint system. Tank bowl recoated in 2012.

j Base of tank in building. Above the roof: epoxy prime coat and polyurethane top coat (in 1994); Inside the bldg: moisture cured polyurethane primer and top coats (in 1998).

k Exterior coating consists of zinc-rich urethane primer then epoxy followed by acrylic polyurethane top coat.

l Trenton tanks were power tool cleaned and overcoated with an urethane/epoxy/urethane paint system in 1990.

m Magnolia Bluff was commercially blasted and coated with a non-lead alkyd system. Some lead remains on the tank.

n 1993 seismic upgrade added all new steel to legs and riser, and coated legs and riser with a non-lead alkyd enamel paint system. The bowls still have the lead based primer as noted.

Table 8 Decommissioned Standpipes and Elevated Tanks ⁹															
	Year Taken Off- Line	Year Const.	Capacity (MG)	Base Elev. (feet) ^a	Overflow Elev. (feet) ^b	Diameter (feet)	Tank Height on Riser (feet)	Tank Material	Date of Last Inspection	Interior Coating		Exterior Coating		Improvements Needed If Returned to Service	Current Uses
										Type ^c	Date Applied	Type	Date Applied		
Regional and Sub-Regional System															
Elevated Tanks															
Myrtle #1	2012 ^d	1919	0.5	506.5	584.5	46	-	Riveted Steel	Feb 96	Vinyl	1982	Lead base Touch-up	1983 2009	Internal recoating.	
Distribution System															
Standpipes															
Barton	2012	1927	1.4	277	326	80	-	Riveted Steel	Jan 98	CTE	1960	Lead base	1981	Internal recoating, roof repairs, drain improvements (air gap), and reconnection. Reconnection	
Woodland Park	2003 ^e	1925	1.0	356	430	50	-	Riveted Steel	Oct 98	Vinyl	1984	Lead base	1980		
Elevated Tanks															
Maple Leaf	2009	1949	1.0	431	530	84.25	25	Welded and Riveted	Jan 98	epoxy	1988/95	Lead base ^f Touch-up	2011	Internal recoating and reconnection.	Communications tower

Updated 1/9/2018

a Top of concrete base, based on North American Vertical Datum (NAVD 88).

b Nominal elevation based on North American Vertical Datum (NAVD 88).

c CTE = Coal Tar Enamel

d This tank has been drained and is not in use, but is still connected to the system.

e Disconnected and decommissioned in 2009.

f Maple Leaf has some remaining red lead primer then coated with moisture cured urethane primer and top coats.

g Decommissioned facilities have been drained, disconnected from the water system or in process of being disconnected, but not demolished, and can be returned to service after the improvements shown are made.

**Table 9
Regional and Sub-Regional System Pump Stations**

	Pump #	Manufacturer	Model	Design Flow (gpm)	Head (feet)	Speed (rpm)	Horse- Power	Comments
Augusta	1	Aurora	411 BF	300	102	1,750	15	Pumps 1 and 2 are continuous duty; alternating daily
	2	Aurora	411 BF	300	102	1,750	15	
	3	Aurora	411 BF	1,200	102	1,750	40	Fire flow only
	4	Aurora	411 BF	2,400	113	1,750	100	
Bothell Way	1	De Laval	T36/30	38,200	80	450	900	
Burien	1	Allis Chalmers	209-648-501	2,000	180	1,760	125	Emergency pump connections for diesel pump.
	2	Allis Chalmers	209-732-501	3,000	180	1,760	200	
	3	Worthington	10-LNHS-18	6,000	180	1,775	350	
Control Works	1	De Laval		1,200		1,760	25	Standby use only
Eastgate	1	Byron Jackson	18-KXH-1-STG	4,250	145	1,770	200	
	2	Byron Jackson	18-KXH-1-STG	4,250	145	1,770	200	
	3	Byron Jackson	18-KXH-1-STG	4,250	145	1,770	200	
Fairwood	1	Aurora	411 BF	750	220	1,750	75	Emergency pump connections for diesel pump.
	2	De Laval	A0615L	2,000	215	1,750	150	
Foy	1	Ingersoll Rand	10 LR 18A	6,000	165	1,785	300	165 ft. head with 15.43"; 290 ft. head with 18" impeller
	2	Ingersoll Rand	8 LR-18S	4,440	165/290	1,778	400	
	3	Ingersoll Rand	8 LR-18S	4,440	165/290	1,778	400	
Highland Park	1	Worthington	10 LNH 18	5,500	175	1,775	300	Small pump can be powered by diesel generator
	2	Worthington	10 LNH 18	5,500	175	1,775	300	
	3	Ingersoll Rand	6 AFV	1,400	140	1,770	60	
Lake Hills	1	Peerless	8AE17A	5,000	160	1,780	250	New 1999 Emergency pump connections New 1999 for diesel pump
	2	Peerless	8AE17A	5,000	160	1,780	250	
Lake Youngs	1	Fairbanks Morse	7000 AW	7,700	182	1,185	500	
	2	Fairbanks Morse	7000 AW	7,700	182	1,185	500	
Maple Leaf	1	Patterson	18X14 MAC	10,300	156	1,180	500	Can be powered by diesel generator
	2	Patterson	18X14 MAC	7,200	156	1,180	350	
Maplewood	1	Worthington	20 LN 28	17,750	108	720	600	Standby use only, low hours
North City	1	Worthington	12 LN 14	6,500	113	1,775	250	
	2	Worthington	12 LN 14	6,500	113	1,775	250	
Trenton	1	De Laval		1,000	225	1,845		Water Turbine Powered
	2	De Laval		3,000	225	1,200		Water Turbine Powered
TESS	1	Worthington	8 LP 13	1,600		1,770	100	Diesel pump
	2	Aurora		3,500	272		100	

Source: Capron 2011, Goodman 2011

Notes:

gpm = gallons per minute

rpm = revolutions per minute

Vert. = vertical

Table 10 Distribution System Pump Stations								
	Pump #	Manufacturer	Model	Design Flow (gpm)	Head (feet)	Speed (rpm)	Horse- Power	Comments
Bitter Lake	1	Gould	3405	4,000	162	1,775	200	Diesel standby use only
	2	Gould	3405	4,000	162	1,775	365	
	3	Gould	3405	4,000	162	1,775	200	
Broadway	1	Fairbanks Morse	2844C	4,700	245	1,781	400	
	2	Fairbanks Morse	2844A	2,800	237	1,784	250	
	3	Fairbanks Morse	K65226	4,000		1,150	300	
Dayton Ave.	1	De Laval	56064	1,400	110	1,750	50	
	2	MP		100	100	3,450	5	
First Hill ⁽¹⁾	3	Fairbanks Morse	2824C	2,800	180	1,775	200	
	4	Fairbanks Morse	2824C	4,900	190	1,775	350	
Green Lake	1	De Laval	98851	900	331	1,750	93	Water Turbine Powered
Interbay	1	Worthington	10 LN 18	3,500	110	1,185	125	Low service
	2	Worthington	8 LA 4	3,500	230	1,785	300	High service
Lincoln	1	Worthington		3,900	117	1,540	125	Water turbine powered
Northgate	1	Allis Chalmers	205-603-502	5,500	182	1,760	300	
	2	Allis Chalmers	205-603-501	5,500	182	1,760	300	
Queen Anne	1	Berkeley	B2TPMS	170			5	Variable frequency drive
	2	Berkeley	B2TPMS	170			5	Variable frequency drive
	3	Berkeley		450			15	Variable frequency drive
	4	Berkeley		2,400			40	
Roosevelt	1	Allis Chalmers	201-052-501	3,000	110	1,760	100	
	2	Allis Chalmers	201-052-501	3,000	110	1,760	100	
Scenic Heights	1	Aurora	411 BF	450	95	1,750	20	
	2	Aurora	411 BF	450	95	1,750	20	
	3	Aurora	411 BF	1,100	100	1,750	40	
	4	Aurora	411 BF	1,100	100	1,750	40	
SW Spokane	1	Allis Chalmers	207-52-510	4,000	290	1,760	400	New starters and transfer switch in 1997; can be powered by diesel gen.
	2	Allis Chalmers	207-52-510	4,000	290	1,760	400	
Viewridge	1	Layne		2,500		1,750	100	To 326 zone
	2	Layne		3,500		1,750	350	To 530 zone
Volunteer	1	Allis Chalmers	201-194-502	4,000	108	1,760	125	
	2	Allis Chalmers	201-194-501	4,000	108	1,760	125	
Warren Ave.	1	Allis Chalmers	207-521-510	4,000	265	1,770	350	Can be powered by diesel generator.
	2	Allis Chalmers	207-521-509	4,000	265	1,770	350	
West Seattle	1	Ingersol Rand	10 AFV	4,500	62.3	1,750	100	One pump can be powered by diesel generator
	2	Ingersol Rand	11 AFV	4,500	62.3	1,750	100	

Source: Capron 2011, Goodman 2011

Notes:

(1) First Hill pump station has two pumps, they are labeled 3 and 4. The pumps work in conjunction with pumps 1 and 2 and the Broadway pump station.

Notes:

gpm = gallons per minute

rpm = revolutions per minute

Vert. = vertical

Table 11 Metered Connections by Classification and Size												
CLASSIFICATION	CONNECTION SIZE (inches)											TOTAL
	3/4	1	1-1/2	2	3	4	6	8	10	12	20	
Residential ¹	149,558	17,509	1,325	470	1	3	1	1	-	-	-	168,868
Commercial ²	6,239	4,889	3,586	4,565	499	973	383	129	38	7	2	21,310
Fire Service	524	1	8	650	27	1,615	1,337	756	29	6	-	4,953
RETAIL SERVICE TOTAL³	156,321	22,399	4,919	5,685	527	2,591	1,721	886	67	13	2	195,131

Source: SPU Meter Count By Connection Size Report, July 1, 2017.

¹ Includes single-family residences, duplexes, and other residential services.

² Includes multi-family residences, commercial properties and municipal services.

³ Includes services in Shoreline, Lake Forest Park, and other locations outside the City of Seattle.

Table 12
Interties From Seattle Public Utilities to Other Purveyors
As of June 2018

SPU Station	Meter Size (inches)	Service Location	Comments/Notes
CITY OF BELLEVUE			
47	8	128 th Ave SE & SE 56 th ST	
55	6	128 th Ave SE & Newport Way	
56	8	128 th Ave. SE & Newport Way	
58	12	145 th Pl. SE & SE 28 th Street	
59	8	132 nd Ave. SE & SE 26 th Street	
60	10	14509 SE Newport Way	
61	24	152 nd Ave. NE & NE 8 th Street	
62	12	132 nd Ave. NE & Bel-Red Road	
63	10	132 nd Ave. NE & NE 24 th Street	
65	10	140 th Ave. NE & 40 th Street	
66	8	Mercer Is. Pipeline & 108 th Ave. SE	Bellevue is planning to replace this meter in 2020, at the same general location but with a large meter.
124	8	124 th Ave SE & SE 38 PL	
182	10	14509 SE Newport Way	
198	TBD	TBD	Bellevue is planning to add another TESSL meter station in the vicinity of NE 8th & 136th Ave in 2021.
CITY OF BOTHELL			
95	10	TRPL R/W - 104TH NE	
96	8	NE 180TH & 88TH NE	
99	6	TRPL & 96TH NE STA 1335	
CEDAR RIVER WATER AND SEWER DISTRICT			
30	8	141 st Ave SE and SE 171 st Way	
166	10	19201 SE Petrovitski Road	
187	10	FWPL4 at NE corner of Control Works property	
COAL CREEK UTILITY DISTRICT			
48	8	129 th Ave SE & SE 73 rd ST	
52	12	128 th Ave SE & SE 70 th ST	
54	4	132 nd Ave SE & SE 96 th ST	Meter not used, for backup only.
CITY OF DUVALL			
111	4	TOLT RIVER PIPELINE	
112	6	TRPL - STA 657 + 29	
CITY OF EDMONDS			
110	10	SE Corner N 205TH & Fremont AV	Emergency Intertie only.
HIGHLINE WATER DISTRICT			
41	12	Des Moines Way S & S 207 th Street	
42	16	160 th Ave S & Military Road S	
43	12	Des Moines Way S & S Normandy Road	
CITY OF KIRKLAND			
72	12	140 th Ave. NE & NE 70 th Street	
74	10	132 nd Ave. NE & NE 113 th Street	
75	16	132 nd Ave. NE & NE 85 th Street	
LAKE FOREST PARK WATER DISTRICT			
188	8	Tolt Pipeline ROW & NE 195th St	Emergency Intertie only.
CITY OF MERCER ISLAND			
67	12	SE 43 rd Street & 89 th Ave SE	
68	6	SE 40 th Street & 97 th Ave SE	
171	10	E Mercer Way & Mercer Island Pipeline Right-Of-Way	Mercer Crest Water Association was taken over by City of Mercer Island.
197	3/4	E Mercer Way @ Mercer Island Pipeline	
CITY OF NORTH BEND			
190	8	101 R @ SCL PP "RT 1-73"	
NORTHSHORE UTILITY DISTRICT			
81	6	Tolt Pipeline ROW & 119 th Ave. NE	
83	10	Tolt Pipeline ROW & 112 th Ave. NE	

Table 12 Interties From Seattle Public Utilities to Other Purveyors As of June 2018			
SPU Station	Meter Size (Inches)	Service Location	Comments/Notes
NORTHSHORE UTILITY DISTRICT (continued)			
85	6	Tolt Pipeline ROW & 104 th Ave. NE	
86	20	88 th Ave. NE & NE 180 th Street	
89	6	64 th Ave. NE & NE 185 th Street	
90	6	64 th Ave. NE & NE 185 th Street	
92	6	40 th Place NE & NE 195 th Street	
93	12	Tolt Pipeline ROW & NE 195 th Street	
94	10	132 nd Ave. NE & NE 132 nd Street	
OLYMPIC VIEW WATER AND SEWER DISTRICT			
107	8	8 th Ave. NW & NW 205 th St.	
108	8	Fremont N. & N. 205 th St.	
109	8	Fremont N. & N. 205 th St.	
192	6	24th Av NW & NW 205th St.	
CITY OF REDMOND			
164	10	Trilogy Parkway NE & NE 125th Street	
165	10	160 th Ave NE & NE 104 th Street	
185	6	NE 172 nd Street & Tolt Pipeline #2	
186	10	Trilogy Parkway NE & NE 125th Street	
CITY OF RENTON			
33	6	9602 S 160TH ST	
34	8	CRPL 4 - ST HWY 5 - C	
36	6	7TH - JONES ST - PL R/W	
37	3	PLAT RENTON	
38	6	CRPL & 84TH AV S	
39	10	CRPL RW & LK YOUNG WY	
179	10	Logan St & 2nd	Formerly SPU direct service to Boeing Renton plant.
180	10	Logan St & 2nd	Formerly SPU direct service to Boeing Renton plant.
196	8	7501-8001 S 153rd Pl	Serves Boeing/Longacres.
NORTH CITY WATER DISTRICT			
101	10	8 th Ave NE & NE 160 th Street	
102	10	16 th Ave NE & NE 192 nd Street	
103	6	32 nd Ave NE & NE 195 th Street	
104	8	8 th Ave NE & NE 185 th Street	
191	8	NE 195th St & 47th Pl NE	
193	8	NE 185th & 5th Ave NE	
194	8	NE 185th & 8th Ave NE	
SKYWAY WATER AND SEWER DISTRICT			
1	8	84 th Ave. S & S 134 th Street	
5	8	Beacon Ave S & S 124 th Street	
172	6	Cornell Ave S & S 112th Street	
SOOS CREEK WATER AND SEWER DISTRICT			
27	10	148 th Ave SE and SE 192 nd Street	
28	10	SE 164 TH Street and 132 nd Ave SE	
29	8	SE 160 TH Street and 114 th Ave SE	
181	6	147 th Ave SE and SE Petrovitski Road	
189	10	SE 164th & 132nd SE (next to Sta.28)	
CITY OF TUKWILA			
13	10	South Center Parkway & Tukwila Parkway	
14	8	West Valley Hwy & S 162 nd Street	
15	8	Christensen Rd. & Baker Rd	
16	6	53 rd Ave S & S 160 th Street	
183	12	E Marginal Way & S 112 th Street	
168	12	7749 E Marginal Way S	
169	8	51 st Ave S & S Leo Street	
170	12	W. Marginal Place & S 102 nd St.	
173	6	47 th Ave S & S Victor Street	

Table 12 Interties From Seattle Public Utilities to Other Purveyors As of June 2018			
SPU Station	Meter Size (inches)	Service Location	Comments/Notes
WOODINVILLE WATER DISTRICT			
53	8	TPL1 at pipeline station 1120	
57	6	TPL1 at pipeline station 1061	
76	4	TPL1 at 124 th Ave NE	
77	6	132 nd Ave NE & NE 140 th Street	
78	8	TPL1 at Welcome Road Valve Station	
79	8	TPL1 at Avondale Road	
80	8	TPL1 at 168 th Ave NE	
123	6	TPL1 at pipeline station 1197	
125	6	TPL1 at pipeline station 1049	
167	6	15002 132nd Ave NE	
195	6	132nd Ave NE & NE 144th Street	
KING COUNTY WATER DISTRICT #20			
19	16	12th Ave S & S 112th Street	
23	6	14th Ave SW & SW 149th Street	
126	8	8th Ave S & Aqua Way	
127	6	Des Moines Memorial Dr. & S 112th Street	
128	6	Military Road & S 125th Street	
129	6	Military Road & S 128th Street	
130	6	14th Ave S & S 112th Street	
132	8	4th Ave SW & SW 108th Street	
133	10	4th Ave SW & SW 128th Street	
134	4	Ambaum Blvd SW & SW 132nd St.	
135	6	14th Ave S & S Director Steet	
136	10	8th Ave S & S 146th Street	
KING COUNTY WATER DISTRICT #45			
20	8	4 th Ave SW & SW 108 th Street	
176	6	12 th Ave SW & SW 106 th Street	
184	6	8 th Ave SW & SW 99 th Street	
KING COUNTY WATER DISTRICT #49			
25	8	16800 DesMoines Wy S	
139	10	10TH AV SW - SW 149TH	
140	12	DesMoines Way S. & 160th Ave S	
142	8	8TH AV SW - SW 146TH	
143	10	DESMOINES WY & AMBAUM	
KING COUNTY WATER DISTRICT #90			
45	10	132ND AV SE & SE 128TH	
KING COUNTY WATER DISTRICT #119			
116	4	ODELL STA 612 THRU 36 30	
117	6	34801 TOLT PL RW	
KING COUNTY WATER DISTRICT #125			
8	6	CRPLs 1,2 & 3 and S 131 st Street	
9	6	42 nd Ave S & S 160 th Street	
10	8	Pacific Highway S & S 160 th Street	
17	10	8 th Ave S & S 146 th Street	
119	6	CRPLs 1,2 & 3 and S 124 th Street	
120	8	E Marginal Way & S 115 th Street	
121	4	Military Road & S 135 th Street	
174	10	2400 S 146 th Street	Boeing Fire Service.
175	10	2400 S 146 th Street	Boeing Fire Service.

SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN
APPENDIX C

POLICIES, PROCEDURES AND STANDARDS

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-1
Comprehensive Water Quality Monitoring Summary

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Seattle Public Utilities Comprehensive Water Quality Monitoring Summary August 2017

1.0 Overview

Providing public health protection is a primary concern in the operation and maintenance of a public drinking water system. Determining the adequacy of this protection is accomplished with a comprehensive monitoring program that covers the source of supply, treatment systems, the distribution system, and customers' taps. Sampling requirements are established by federal regulations, such as the Safe Drinking Water Act (SDWA), which are in most cases adopted by the state. Seattle Public Utilities (SPU) conducts monitoring in accordance with the Safe Drinking Water Act and Washington State Department of Health requirements, Chapter 246-290 WAC.

This summary of water quality monitoring addresses the following:

- Monitoring requirements under state and federal drinking water regulations;
- Future regulations, which are currently under development at the federal level;
- Non-regulatory monitoring, which SPU conducts for informational purposes and to assist in operating the water system;
- Sampling procedures;
- Laboratory Information Management System (LIMS); and,
- All parameters, locations, and frequency of monitoring conducted by SPU. Monitoring locations include source, treatment, transmission and distribution system, and customer taps.

A concise summary of SPU's monitoring requirements is shown in Table 1. This table includes source water and distribution system monitoring required by regulation. Monitoring of treatment operations required by the Surface Water Treatment Rule or Lead and Copper Rule is not included in Table 1, but is discussed below, and is reflected in Table 2.

Table 2 is a summary of the monitoring currently conducted by SPU and is organized by sampling locations, frequencies, and parameters. This table includes monitoring required by regulations, and monitoring conducted for operational or informational purposes (non-regulatory). All monitoring shown is directly related to the drinking water supply. Monitoring related to special studies, customer inquiries, disinfection of new mains, construction of facilities, environmental compliance when dewatering facilities, wellhead protection, aquifer recharge, source development, treatment chemicals, or other monitoring conducted for purposes other than drinking water quality compliance is not included in this document.

DOH has the authority to grant waivers for certain parameters, depending on vulnerability and previous sampling results. If a system is considered to have low vulnerability to contamination from a certain chemical or group of chemicals, the State may waive the requirements for

sampling, or reduce the number of samples required. The State issued waivers for SPU for Inorganic Chemicals (IOCs), Volatile Organic Chemicals (VOCs), and Synthetic Organic Chemicals (SOCs). IOCs must now be submitted to the state once every 9 years, VOCs must be submitted once every 6 years, and herbicides once every 9 years. There are also several area-wide waivers in effect for several of the SOCs. These waivers apply to all systems within the designated area.

SPU operates its own State-certified laboratory for a majority of the parameters monitored. This includes total coliform, fecal coliform, HPC, most inorganic chemicals, trihalomethanes, haloacetic acids, lead, copper, VOCs, and all SWTR parameters. Samples for SOCs, asbestos, some inorganics, and *Cryptosporidium* and *Giardia* are sent to other laboratories certified by the state or EPA for the analysis.

Adjustments to monitoring are often required based on operational considerations, detection of organic chemicals, construction projects, or as required by the state based on a public health concern. SPU will work with the State to determine appropriate changes to the monitoring program to address any concerns that may arise.

2.0 Monitoring Requirements

The following summarizes the monitoring requirements for existing and future regulations. Existing regulations include those finalized by EPA and published in the Federal Register under 40 CFR Part 141. Any regulation the state has adopted into Chapter 246-290 WAC with changes or additions are also discussed under existing regulations. Future regulations include those currently proposed by EPA.

2.1 Existing Regulations

The existing regulations discussed below are organized by their common name with a reference to the appropriate federal and state section numbers.

Total Coliform Rule (40 CFR 141.21 and WAC 246-290-300 (3))

SPU collects and analyzes coliform samples from representative points throughout the direct service area as outlined in SPU's Coliform Monitoring Plan (attached without appendices). These samples are collected at designated sample stands according to established routes assigned by the Senior Water Quality Analyst or designee. Routes are designed to cover both the Cedar and Tolt service areas each day; with most sample stands being sampled weekly. To meet regulatory requirements, SPU must collect at least 270 coliform samples from its direct service area each month. The chlorine residual is also analyzed in the field at the time of coliform sample collection as required by state regulations. Temperature is also measured, although not required.

For any sample found to be positive for total coliform, or invalidated, follow-up action is taken according to state and federal regulations, as described in SPU's Coliform Monitoring Plan. This

follow-up action may include additional sample collection, additional analyses such as fecal coliform, *E. Coli*, or HPC, and notification to the state. SPU's Coliform Monitoring Plan lists all sample locations, schedules, test methods used, follow-up sampling requirements, and notification requirements.

Surface Water Treatment Rule (40 CFR 141.70-75 and WAC 246-290 Part 6)

The Surface Water Treatment Rule (SWTR) requires a significant amount of monitoring for SPU's filtered surface water supply, the South Fork Tolt River. This includes raw water, treated water, and distribution system water monitoring as follows.

Raw Water Monitoring – Continuous monitoring of turbidity at the inlet to the Tolt Treatment Facility occurs as required by the SWTR. Samples analyzed for fecal coliform density are collected at the inlet to the Tolt Treatment Facility daily, for at least 27 days a month.

Treated Water Monitoring – Treated water monitoring for the SWTR consists of monitoring required to determine the effectiveness of the disinfection process. This includes monitoring to determine log reduction of *Giardia* cysts and viruses. To determine the log reduction for virus, the pH, chlorine residual, temperature, clearwell volume, and peak hourly flow rate must be recorded. For the Tolt system, this monitoring is continuous, but is reported once a day at peak hourly flow. To determine the log reduction for *Giardia*, the pH, ozone residual at multiple locations along the contact chamber, temperature, and peak hourly flow are recorded. CT is calculated for each section of the ozone contact chamber. Ct is reported to the state for both the peak hourly flow and at minimum daily CT.

In addition, continuous chlorine residual monitoring for water entering the distribution system occurs at the outlet of the Tolt Treatment Facility. Turbidity is also monitored continuously at each individual filter unit and from the combined filter effluent.

Additional monitoring is conducted at the treatment plant to meet the requirements of the Service Agreement with the DBO contractor. This monitoring is summarized in Table 3.

Distribution System Monitoring – Residual disinfectant concentration is measured at the same time and location that a routine or repeat coliform sample is collected within the distribution system.

Limited Alternative to Filtration (WAC 246-290-691)

Beginning in November 2004, the Cedar water supply system was designated a Limited Alternative to Filtration status. As such, the source and treated water monitoring requirements are slightly different than an unfiltered surface water source subject to the SWTR. This includes raw water, treated water, and distribution system water monitoring as follows.

Raw Water Monitoring – Continuous turbidity monitoring occurs at the Cedar Treatment Facility for the raw water coming from Lake Youngs (or Landsburg during by-pass operations). Fecal

coliform samples are also collected at this location once per day for a minimum of 5 days a week.

Treated Water Monitoring – Treated water monitoring consists of monitoring to determine inactivation of Giardia, Cryptosporidium, and viruses. This monitoring is conducted continuously for the ozonation system, UV treatment, and chlorination. For ozone inactivation of Giardia and viruses, monitoring includes temperature, initial ozone concentration, ozone decay, and flow rate. For inactivation of Giardia and Cryptosporidium with UV, monitoring consists of flow rate through each reactor, UV transmittance, UV dose, lamp power, and lamp hours. For inactivation of viruses with chlorine, monitoring includes flow rate, clearwell volume, pH, chlorine residual, and temperature.

Finished water entering the system is continuously monitored for chlorine residual, temperature and pH. Daily samples are also analyzed for coliform, although this is not required by regulation. Additional monitoring is required to meet the Service Agreement with the DBO contractor. Service Agreement monitoring is summarized in Table 3.

Distribution System Monitoring – Residual disinfectant concentration is measured at the same time and location that a routine or repeat coliform sample is collected within the distribution system.

Disinfectants/Disinfection By-Products Rules (40 CFR 141.130-135, 141, 142) and WAC 246-290-300 (6)

Current regulations (Stage 2) require trihalomethane (THMs) and haloacetic acids (HAAs) monitoring in the distribution system. SPU is required to collect twelve samples each quarter at existing sample stands within the direct service area under an approved monitoring schedule. The 12 locations were selected based on results from the Initial Distribution System Evaluation (IDSE). They represent the locations that had the highest TTHM and HAA values during the IDSE. The samples are always collected during the first week of the second month of each quarter. Compliance under the Stage 2 Rule is based on locational running annual averages instead of system wide running annual averages.

Monitoring for chlorine residual currently conducted at total coliform sample sites in the direct service area are reported under the Stage 2 rule. Bromate monitoring is conducted for the Tolt and Cedar supplies now that ozonation facilities for each supply are in operation. The monitoring for bromate is conducted monthly at the entry to the distribution system.

Lead and Copper Rule (40 CFR 141.80-91)

SPU has conducted monitoring for lead and copper at customers' taps according to the regulations and the Regional Lead and Copper Monitoring Program. These homes were selected based on criteria in the Lead and Copper Rule. Since 2005, the homes were divided into four sub regions. Since 2008, each region has qualified for reduced monitoring. Currently, 50 samples are collected from the Seattle direct service area, 50 are collected from Bellevue, 50 are collected from the participating wholesale providers receiving water from the Cedar supply, and 50 are

collected from the participating wholesale providers receiving water from the Tolt supply. Compliance was based on the 90th percentile for each sub-region. Each sub-region is currently required to sample once every three years. Monitoring requirements would change if the lead or copper action levels were exceeded. The Cedar wholesale provider group will collect samples in 2018, Seattle direct service area will collect samples in 2019, and the Tolt wholesale provider group will collect samples again in 2020.

Water quality parameter monitoring at the treatment plants and within the distribution system is also required for the lead and copper rule. Monitoring of pH is required at the Cedar Treatment Facility and both pH and alkalinity are required at the Tolt Treatment Facility. The distribution system monitoring currently includes collecting 10 samples each quarter and analyzing the samples for pH and alkalinity. The 10 locations are distributed throughout the direct service area and Cedar and Tolt wholesale sub-regions that are part of the regional monitoring program.

Inorganic Contaminants, VOCs, SOCs (40 CFR 141.23-23, 40 and WAC 246-290-300 (4) and (7))

Primary and Secondary inorganic contaminants (IOCs), volatile organic chemicals (VOCs), and synthetic organic chemicals (SOCs) are monitored according to state and federal requirements. IOCs for the Cedar and Tolt supplies have a state waiver, and are required once every nine years. VOCs also have a state waiver, and are required once every six years, with the samples collected from the entry point to the distribution system, after treatment. The Riverton and Boulevard Park Wells are sampled for IOCs and VOCs at the entry point to the distribution system prior to the first customer, at varying frequencies, or when in operation. SOCs are monitored as directed by the state, and the frequency is dependent on waiver status. SOCs were last collected in 2008 (pesticides) and 2016 (herbicides).

Radionuclides (40 CFR 141.26 and WAC 246-290-300 (8))

The radionuclides rule requires monitoring for gross alpha, radium 226, radium 228, and uranium. This monitoring is conducted for each source at the entry point to the distribution system. Monitoring occurred in 2015 for the Tolt and Cedar, and is currently required once every 6 years.

Fluoride (WAC 246-290-460)

As required by state regulations, fluoride is monitored daily at each point of fluoride addition and a report is submitted to the state monthly. For process control purposes, fluoride concentration is monitored continuously with an online instrument. In addition to fluoride monitoring at the treatment plants, a grab sample is collected daily and analyzed at SPU's Water Quality Laboratory as a check. Results for one monthly check sample are submitted to the state.

Unregulated Contaminants Monitoring Rule (40 CFR 141.35, 40)

The Unregulated Contaminants Monitoring Rule requires additional monitoring for SPU. For UCMR 3, samples were collected at the entry point to the distribution system, and at maximum

residence time locations in the distribution system, in 2015. The next UCMR monitoring (UCMR 4) is required sometime between 2018 and 2020.

Groundwater Rule (40 CFR 141.400 - 405)

Only the Riverton and Boulevard Park Wells are subject to this regulation. SPU has decided to use triggered source water monitoring for the compliance strategy. This means a source water *E. Coli* sample will need to be collected from the wells any time the wells are in operation, and a TCR compliance sample from the area fed by the wells is positive. The sample must be collected within 24 hours notice.

Cryptosporidium Monitoring for LT2SWTR (40 CFR 141, Subpart W)

Monthly monitoring to determine compliance with LT2SWTR was completed in March 2017. The results of *Cryptosporidium* monitoring are reported in the annual Drinking Water Quality Report sent to customers each year. Compliance samples were collected from two locations: Tolt Regulating Basin outlet (TPR-4), and Landsburg forebay (CPR-1) prior to treatment. The next round of monthly monitoring for LT2SWTR compliance is required six years after completion of the previous round (possibly 2023 or 2024).

2.2. Future Regulations

The future regulations discussed below are organized by their currently accepted common name which may change in the future. *Federal Register* citations are provided for rules which have been published, either in draft or final form.

Lead and Copper Rule Long-Term Revisions

Based on the Working Group recommendations, there could be changes to Seattle's sampling pool for the lead and copper rule. Future samples may be based on customer requests, may need to be collected at locations with lead whips, and may be spread out over the three-year compliance period. The other possible change is an increase in water quality parameter monitoring in the distribution system. SPU will make any necessary changes to monitoring as required by the final rule.

Perchlorate and Chromium

There is no time frame for when sampling will be required for these two contaminants. SPU will conduct all future monitoring at the frequency and locations required by any future regulation.

2.3. Non-Regulatory Monitoring

Non-regulatory monitoring discussed below includes monitoring performed for informational purposes or to assist in making operational decisions. This monitoring is not required by regulation at this time, but may be required at some time in the future.

Limnology

Bi-weekly, monthly and quarterly monitoring of various limnological parameters is conducted at Lake Youngs, Chester Morse Lake, the Tolt Reservoir proper and reservoir tributary streams, and the Cedar River, and Cedar River tributary streams. In addition, samples are collected occasionally from the Tolt Regulating Basin. This data is collected for informational purposes, and is not required by state or federal regulations. Sample collection occurs at multiple locations and depths in Lake Youngs, Chester Morse Lake, and the Tolt Reservoir. The parameter list includes temperature, dissolved oxygen, transparency, turbidity, conductivity, alkalinity, calcium, pH, phosphorous, iron, manganese, ultra-violet light absorption, total organic carbon, phytoplankton, zooplankton, taste and odor, geosmin, MIB, and more.

Taste and Odor

Taste and Odor are analyzed on a bi-weekly basis for each of SPU's treated source waters and other locations as needed. This monitoring is used to make operational decisions, but is not currently required by state or federal regulations.

Reservoir Protection

Several of SPU's closed reservoirs currently have chlorination at the outlet or within a mixing system, prior to entry to the distribution system. The chlorine residual is monitored continuously to ensure adequate treatment occurs at all times. In addition, all closed storage facilities are sampled twice monthly for field chlorine, temperature, total coliform/E. Coli, and HPCs. Those reservoirs with parks on top are also sampled for metals, nutrients, and general chemistry.

Treatment Processes

Existing source water treatment consists of ozonation, UV light, chlorination, fluoridation, and corrosion control on the Cedar supply. Treatment for the Tolt supply consists of ozonation, coagulation, flocculation, filtration, corrosion control, chlorination and fluoridation. Each of these processes is monitored continuously to ensure adequate treatment is maintained at all times. Portions of this monitoring are required by the regulations discussed above. Significantly more monitoring is required to meet the requirements of the Service Agreements for each DBO contractor operating the treatment plants. This monitoring is summarized in Table 3.

2.4. Sampling Procedures

Proper sample collection is important for accurate results. All laboratory assistants and other staff collecting samples in the field are trained in appropriate sample collection techniques based on parameter. Written sample collection procedures for bacteriological analyses such as total coliform are included in SPU's Coliform Monitoring Plan. Sample collection methods for all regulatory compliance samples follow standard procedures or methods listed in *Standard Methods*. In addition, training for laboratory staff conducting the analyses occurs on a regular basis.

2.5. Laboratory Information Management System (LIMS)

SPU's Water Quality Laboratory uses a Laboratory Information Management System (LIMS), most recently updated in 2016. All water quality samples analyzed at the lab, or samples analyzed by outside laboratories for SPU's drinking water are entered into LIMS. This system provides the means to track sample status, record and validate results, and produce reports. Data from LIMS can then be extracted to other computer programs for long-term storage, analysis, or report formatting.

Table 1
Summary of Drinking Water Quality Monitoring Requirements (Regulatory) - Seattle Public Utilities

Dated: August 2017

Parameter	Locations	Frequency	Monitoring Year	Lab Used	Comments
Inorganic Chemicals					
Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Cyanide Fluoride Lead Mercury Nickel Selenium Sodium Thallium	SO1 at CLT-5 SO2 at TPT-3 SO4 at BPW-T SO6 at RHW-T	Required once every 9 years for all sources.	Last submitted in 2015 for SO1 and SO2. Last submitted in 2012 for SO4 and SO6.	SPU SPU SPU SPU SPU SPU SPU Outside SPU SPU Outside SPU SPU SPU SPU	EPA and State allow waivers. Waivers are applied automatically by the state. No MCL, AL = 1.3 mg/L No MCL, AL = 0.015 mg/L Health Advisory Level = 20 mg/L
Nitrate Nitrite	CLT-5, TPT-3, RHW-T, BPW-T	Annually for SW and GW	Every Year, wells if operated	Outside	Usually done during second quarter of each year.
Asbestos	None	None		Outside	Seattle no longer has AC pipe. No need to sample.
Radionuclides					
Gross Alpha Emitters Radium 226 Radium 228 Uranium	CLT-5, TPT-3, RHW-T, BPW-T	Once every 6 years.	Done for SO1 and SO2 in 2015 Next time wells are used.	Outside	Next due after 2019 for SO1 and SO2.
Organic Chemicals					
VOCs	CLT-5, TPT-5, RHW-T, BPW-T	Once every 3 years for SO6. Once every 6 years for SO1, SO2, and SO4.	Sampled SO1 & SO2 in 2017. SO4 and SO6 in 2012.	SPU	Waivers are applied automatically by the state.
SOCs (Includes herbicides, general pesticides, & insecticides)	CLT-5, TPT-3, RHW-T, BPW-T	Once every 3 years for SO6. Once every 9 years for SO1, SO2, and SO4.	SO1 and SO2 done in 2016. SO6 done in 2015. SO4 done in 2008.	Outside	Waivers are applied automatically by the state.
Dioxin, endothal, Diquat, Glyphosate, EDB & other Soil Fumigants					State waivers
Bacteriological					
Total Coliform Rule	72 distribution system sample stands	270 samples per month	sampling almost daily	SPU	
Chlorine Residual	Same locations as coliform	270 samples per month	sampling conducted daily	SPU	
Lead and Copper					
Lead Copper	At 50 customer taps in DSA	Once every three years	2016	SPU	Wholesale customers have 3 subregions: Cedar, Tolt, and Bellevue each take 50 samples once every 3 years
Water Quality Parameters	T-FINISH, C1-FIN, C2-FIN, 10 dist sites	Treatment: daily; Distribution: quarterly		DBO, SPU	Cedar TF: pH only. Tolt TF & Distribution: pH & alkalinity
Disinfection By-Products					
Trihalomethanes	12 DSA sample stands.	Quarterly	Every Year	SPU	Locations determined by IDSE results.
HAAs (future)	12 DSA sample stands.	Quarterly	Every Year	SPU	Locations determined by IDSE results.
Secondary Contaminants					
Chloride Color Fluoride Hardness Iron Manganese Silver Specific Conductivity Sulfate Total Dissolved Solids Zinc	CLT-5, TPT-3, RHW-T, BPW-T	Once every 9 years for SO1, SO4, and SO6. Once every three years for SO2 (Fe,Mn only)	SO1 and SO2 done in 2015. SO4 and SO6 done in 2012.	Outside SPU SPU SPU SPU SPU SPU SPU Outside SPU SPU	 Only required if conductivity > 700 µmhos/cm
Surface Water Treatment Rule (Tolt)					
Turbidity	TPR-SS 5N, T-CFE, individual filters	Continuous			All Part of DBO Contract
Fecal coliform	TPR-SS 5N	Daily, at least 5 days per week			
Chlorine Residual	T-FINISH	Continuous		SPU	
CT Compliance	Ozone contactors and clearwell	Continuous			For Giardia and Virus inactivation
Limited Alternative to Filtration (Cedar) - LAF					
Turbidity	C1-RAW	Continuous			All Part of DBO Contract
Fecal coliform	C1-RAW, CPR-1	Daily, at least 27 days per month		SPU	
Chlorine Residual	C1-FIN, C2-FIN	Continuous			
CT Compliance	Ozone contactors, UV units, and clearwell	Continuous			For Crypto, Giardia, and Virus inactivation

Table 2
Seattle Public Utilities
Drinking Water Quality Monitoring Conducted – by Parameter
Required and Optional

Parameter	Source	Monitoring Frequency and Location					
		Continuous	Daily or M-F	Weekly or Biweekly	Monthly	Quarterly	Annually
Turbidity	Cedar	CPR-1, C1-RAW, C1-FIN, C2-FIN, security sites	CPR-1, CT-2	C1-Raw, CPT-05, 3 sites on LY, Masonry Dam and 200 bridge, Cedar River and Tributaries	3 sites on CMR, LSC	CLT-5, M-1A	
	Tolt	TPR-5S 5N, T-FINISH, T-CFE, Filter Effluents, reclaimed water, Reg Basin Inlet	TPR-4, TT-1		4 sites Tolt Reservoir, TW-10	TPT-3, B-2, 9 Tolt Streams	
pH	Cedar	C1-RAW, C1-CWI, C2-CWI, C1-FIN, C2-FIN	CPR-1, CLT-5, CT-2	30+ TCR sites, Masonry Dam, 4 sites on LY, C1-RAW, CPT-05, Cedar River and Tributaries	4 sites on CMR, LSC, Finished Reservoirs with Parks on top	12 DBP sites, 10 LCR WQP sites, 10 sites on Quarterly route	
	Tolt	TPR-5S 5N, T-FINISH, T-CWI,	TT-1, TPR-4	TT-3, T-CFE	4sites Tolt Reservoir, TW-10, TT-2	9 Tolt Streams	
Conductivity	Cedar	Security sites	CPR-1, CLT-5, CT-2	30+ TCR sites, Masonry Dam, 4 sites on LY, C1-RAW, CPT-05, Cedar River and Tributaries	4 sites on CMR, LSC, Reservoirs with Parks on top	CLT-5, M-1A	
	Tolt		TT-1	TT-3	TPR-4, 4 sites Tolt Reservoir, TW-10, TT-2	TPT-3, B-2, 9 Tolt Streams	
Fluoride	Cedar	CPT-00	CPT-00, CT-2	6 sample stands, T-FINISH	TT-2	8 QTR sites	
	Tolt	T-FINISH, T-CWI	TT-1				
Chlorine Residual	Cedar	CPT-00, 3 locations at CTF, 7 reservoirs	CLT-4, 5, CT-1, 2, 3, CPT-04, -05	Closed tanks, standpipes, and reservoirs, TT-3, WSP-1, CT-4, all TCR sites DSA	SH-1, SFD-10	12 DBP sites, QTR sites, 10 LCR WQP sites	
	Tolt	T-FINISH, T-CWI, LFP, BLR	TT-1, 2, 11				
Total Coliform - PA	Cedar		CLT-4,5, CT-1, 2, 3, C1 and C2-FIN	Closed tanks, standpipes, and reservoirs, CT-4, TT-3, WSP-1, all TCR sites DSA	SH-1, SFD-10		
	Tolt		T-FINISH, TT-1, 2, 11				
Total Coliform – MPN	both		CPR-1, C1-RAW, TPR-5S	Masonry Dam, 200 bridge, WLD-1, TPR-4, 3 sites LY	3 sites CMR, TPR-4, TW-10		
Fecal Coliform	Cedar		CPR-1, C1-RAW, C1-FIN, C2-FIN				
	Tolt		TPR-5S				
HPC	Cedar		CPR-1, C1-RAW, CLT-4, 5, C1-FIN, C2-FIN, CT-2	Closed tanks, standpipes, and	3 Sites CMR, 3 sites LY, 2		

Table 2
Seattle Public Utilities
Drinking Water Quality Monitoring Conducted – by Parameter
Required and Optional

Parameter	Source	Monitoring Frequency and Location					
		Continuous	Daily or M-F	Weekly or Biweekly	Monthly	Quarterly	Annually
	Tolt		TPR-5S, TT-1, 2, 11, T-FINISH	reservoirs, WSP-1, WLD-1	sites Tolt, average of 40 TCR sites per month, CT-4		
Temperature	Cedar	C1-RAW, Control Works, CPR-1 (at USGS)	CPR-1, CLT-4, 5, CT-1, 2, 3, C1-FIN, C2-FIN, C1-RAW	Closed tanks, standpipes, and reservoirs, CT-4, TT-3, T-CFE, WSP-1, CPT-04 05, all TCR sites, Cedar River and Tributaries	TPR-4, SFD-10, SH-1	12 DBP sites, 8 quarterly sites, 9 Tolt streams, 10 LCR WQP sites	
	Tolt	TPR-5S, 5N	TT-1, 2, 11, TPR-5S 5N, T-FINISH, TW-10				
UVA	Both	CPR-1	CPR-1	TPR-5S, T-CFE, CPT-05, C1-RAW, Masonry Dam, 200 bridge, 3 LY sites, Cedar River and Tributaries	3 CMR sites, 4 Tolt Res sites, 3 LY sites, TW-10, TPR-4, LSC	9 Tolt streams, 8 quarterly sites	
TOC	Both			CPR-1, TPR-5S, T-CFE, CPT-05, C1-RAW, 3 LY sites, Masonry Dam, 200 bridge, Cedar River and Tributaries	3 sites CMR, 4 sites Tolt Res, 3 sites LY, TPR-4	9 Tolt streams, 8 quarterly sites	
Taste and Odor	Both			CPT-05, CT-2, C1-RAW, C1-FIN, C2-FIN, T-FINISH			
Alkalinity	Both			CPT-05, CPR-1, C1-RAW, 3 LY sites, T-FINISH, Masonry Dam, 200 bridge, Cedar River and Tributaries	TT-3, TPR-4, TW-10, 3 CMR sites	8 QTR sites, 9 Tolt streams, 10 Pb/Cu sites,	

Note: Sampling for Riverton and Boulevard Park Wells is not included in this table.

Table 3
Seattle Public Utilities
Drinking Water Quality Monitoring Conducted by DBO Contractors
Continuous Monitoring

Parameter	Tolt Water Treatment Facility					
	Reclaimed Water	Raw Water	Ozone Contactors	Filter Effluents	Combined Filter Effluent	Clearwell Effluent
Turbidity	X	X		X	X	X
Temperature		X				
pH		X			X	X
Particle Count		X		X(1)	X	
Ozone Concentration			X			
Chlorine Residual					X	X
Fluoride					X	X
Parameter	Cedar Water Treatment Facility					
	Raw Water	Ozone Contactors	UV Reactors	Clearwell Influent	Clearwell Effluent	Finished Water
Turbidity	X					X
Temperature	X					
pH	X			X		X
Ozone Concentration		X				
UV Transmittance, UV Dose			X			
Chlorine Residual				X	X	X

Tolt grab sample parameters include coliform, alkalinity, bromate, iron, sodium, taste and odor, TTHMs and HAAs SDS, Color, TOC, and UVA.

Cedar grab sample parameters include coliform, bromate, iron, chlorophyll, sodium, turbidity, TOC, Color, UVA, and taste and odor.

SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-2

Design Standards and Guidelines – Water Infrastructure

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Chapter 5 WATER INFRASTRUCTURE

This chapter presents Design Standards and Guidelines (DSG) for Seattle Public Utilities (SPU) water infrastructure. Facilities included here are transmission and distribution pipelines, storage tanks, standpipes, and reservoirs. The information in this chapter should be used in conjunction with other DSG standards. For water service connections, see DSG Chapter 17, Water Service Connections.

The primary audience for this chapter is Seattle Public Utilities (SPU) engineering staff. See DSG Chapter 6, Cathodic Protection.

Standards appear as underlined text.

Note: *This DSG does not replace the experienced engineering judgment of a registered professional engineer. All design for upgrade, repairs, and new infrastructure should be done under the supervision of an experienced licensed engineer.*

5.1 KEY TERMS

The abbreviations and definitions given here follow either common American usage or regulatory guidance. Definitions for key elements of the SPU water system are given near the beginning of section for that element. For standard City of Seattle abbreviations for construction drawings, see Section 1-01.2 of the City of Seattle Standard Plans.

5.1.1 Abbreviations

Abbreviation	Term
AC	asbestos concrete
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
ARV	air release valve
AVV	air & vacuum valve
ASTM	American Society for Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
BFV	butterfly valve
BNSF	Burlington Northern Santa Fe
CAV	combination air valve (includes both air release and air vacuum functions)
CDF	controlled density fill

Chapter 5 Water Infrastructure

Abbreviation	Term
CI	cast iron
CIP	Capital Improvement Program
CIPP	cured in place pipe
CSO	combined sewer overflow
DI	ductile iron
DIP	ductile iron pipe
DIPRA	Ductile-Iron Pipe Research Association
DOH	Department of Health
DV	district valve
ECA	environmentally critical area
fps	feet per second
ft	foot or feet
gpm	gallons per minute
GV	gate valve
HDD	horizontal directional drilling
HGL	hydraulic grade line
HP BFV	high pressure butterfly valve
HPA	Hydraulic Project Application
HPC	heterotrophic plate count
IBC	International Building Code
ID	inside diameter
LOB	line of business
mgd	million gallons per day
NACE	National Association of Corrosion Engineers
NPDES	National Pollution Discharge Elimination System
NSF	National Sanitation Foundation
O&M	operations and maintenance
OD	outside diameter
OSHA	Occupational Safety and Health Administration
PR valve	pressure regulating valve
PRV	pressure relief valve
psi	pounds per square inch
psig	pounds per square inch gauge
QA/QC	Quality assurance/quality control
RE	Resident Engineer
ROV	remotely operated vehicle
ROW	right-of-way
SCADA	Supervisory Control and Data Acquisition
SDCI	Seattle Department of Construction and Inspections
SDOT	Seattle Department of Transportation
SDWA	Safe Drinking Water Act
SMT	Seattle Municipal Tower
Spec	specification
SPU	Seattle Public Utilities
Std	standard
TC	total coliform
VV	Vacuum Valve
WMR	Water Main Rehabilitation
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Administration

Abbreviation	Term
WPPM	Water Planning & Program Management

5.1.2 Definitions

Term	Definition
anode	Location where metal is corroded.
cathodic protection	A means of providing a sacrificial material (usually a metal) to become the point where corrosion occurs. Cathodic protection is a technique used to provide corrosion control to buried or submerged metallic materials. Cathodic protection shifts the electrical potential off anodic sites in a pipeline or other structure. See also anode.
Capital Improvement Program (CIP)	Administered by SPU through its Capital Planning Committee (CPC) to plan, budget, schedule, and implement capital improvement projects, including flooding and conveyance improvements, protection and enhancement of water quality and habitat, protection of infrastructure, and drainage improvements within projects of other City agencies
Customer Service	The section within SPU through which customers purchase all new water services and receive notification of planned outages.
engineering	Generic term for SPU staff responsible for plan review and utility system design for CIP projects.
guidelines	Advice for preparing an engineering design. Design guidelines document suggested minimum requirements and analysis of design elements in order to produce a coordinated set of design drawings, specifications, or lifecycle cost estimates. Guidelines answer what, why, when and how to apply design standards and the level of quality assurance required.
O&M	Generic term for SPU staff responsible for operations and maintenance.
resistivity	The resistance of an environment (either water or soil) to the flow of electrical current.
standards	Drawings, technical or material specifications, and minimum requirements needed to design a particular improvement. A design standard is adopted by the department and generally meets the functional and operational requirements at the lowest lifecycle cost. It serves as a reference for evaluating proposals from developers and contractors: For a standard, the word must refer to a mandatory requirement. The word should be used to denote a flexible requirement that is mandatory only under certain conditions.
Water Quality	A section within SPU that takes water samples and performs drinking water quality tests on new and existing water mains and inspects construction projects to assure pipe work is kept clean.

5.2 GENERAL INFORMATION

SPU water facilities supply water to more than 1.3 million people in the Seattle area, including wholesale customers (purveyors). The Tolt and Cedar watersheds supply most of the drinking water. The Seattle well fields serve as a supplemental water source during droughts and emergencies. Large transmission pipelines deliver water to treatment plants, and from the plants to in-town storage facilities such as tanks and reservoirs. Smaller water pipelines distribute water from in-town storage facilities to the public. Valves control water and isolate sections in the distribution mains, which are monitored by Supervisory Control and Data Acquisition (SCADA). Water services and fire hydrants are connected to distribution mains. Purveyors are connected to transmission mains.

In the SPU system, most water flows via gravity from the watersheds to storage facilities in Seattle. Storage facilities are set at high elevations to supply water via gravity to customers.

Where necessary, pumps are used to lift water to higher elevation storage facilities or to increase water pressure. The system is managed by SPU Facility Operations and Maintenance and monitored through SCADA.

5.2.1 Policy

The guiding policy document for water infrastructure is the SPU 2013 Water System Plan. See Chapter 4 of the plan for SPU policy on water transmission. See Chapter 5 of the plan for SPU policy on water distribution.

5.2.2 System Maps

SPU's water maps are available at the following locations:

- Seattle Engineering Records Vault: Base Maps.
- Customer Service Water GIS (software program). Contact SPU IT Service Desk.
- UtiliView GIS program.
- SMT 45th floor: Printed 400' Water System Map books.
- SMT 47th floor: SPU GIS Mapping Counter.

5.2.3 Water System

The SPU Water System is comprised of raw water watershed reservoirs, transmission pipelines, treatment plants, pump stations, treated water storage facilities and distribution pipelines in pressure zones. The system extends far beyond the Seattle city limits (Figure 5-1).

Transmission pipelines deliver water to various tanks, standpipes, and reservoirs throughout the system and on occasion directly to the distribution system. Fourteen reservoirs and 12 tanks comprise the in-town storage facilities. Water from the in-town facilities is distributed to customers via the distribution system.

Seattle's water transmission system also includes 11 pump stations.

5.2.3.2 Distribution System

The SPU water distribution system contains more than 1,690 miles of water mains. These mains vary in diameter from 4 inches to greater than 30 inches. Most SPU water mains are unlined or mortar-lined cast iron, ductile iron, or steel pipe.

Seattle's water distribution system also includes 19 pump stations and more than 180,000 water service lines and meters serving residential and non-residential properties. Generally, both transmission and distribution mains passing under railroads or similar facilities are encased. Most pipelines do not have corrosion protection. See *DSG Chapter 6, Cathodic Protection*.

See also: *DSG Chapter 11, Pump Stations* and *Chapter 17, Water Service Connections*.

For more information on the history and condition of the water distribution system, see the 2013 Water System Plan.

5.2.3.3 Valves

SPU owns about 21,500 valves of various types that support the SPU Water System. SPU installs most valves where needed for ease of operation and system redundancy.

District valves are installed on the distribution system to separate pressure zones.

Line valves are placed throughout the system to isolate sections of pipe when repairs are needed.

Pressure regulating valves regulate flow between pressure zones.

Blowoff valves are placed on both transmission and water mains at low points to drain pipelines. Blowoff valves are installed at dead end water mains where a hydrant is not installed for water quality flushing. Some blowoffs are on the high side of 16 inch and larger line valves and both sides of line valves if they are essentially level for draining purposes. Inside major facilities, SPU uses blowoff valves for dewatering and flushing operations.

Air valves are installed at the high points and occasionally at grade breaks in the pipeline profile. Air valves either release trapped air from the pipelines when under pressure or allow air into the pipelines while being drained to prevent a vacuum in the pipeline.

Other valves function as bypass, altitude control, or pump control.

5.2.3.4 Infrastructure Elements

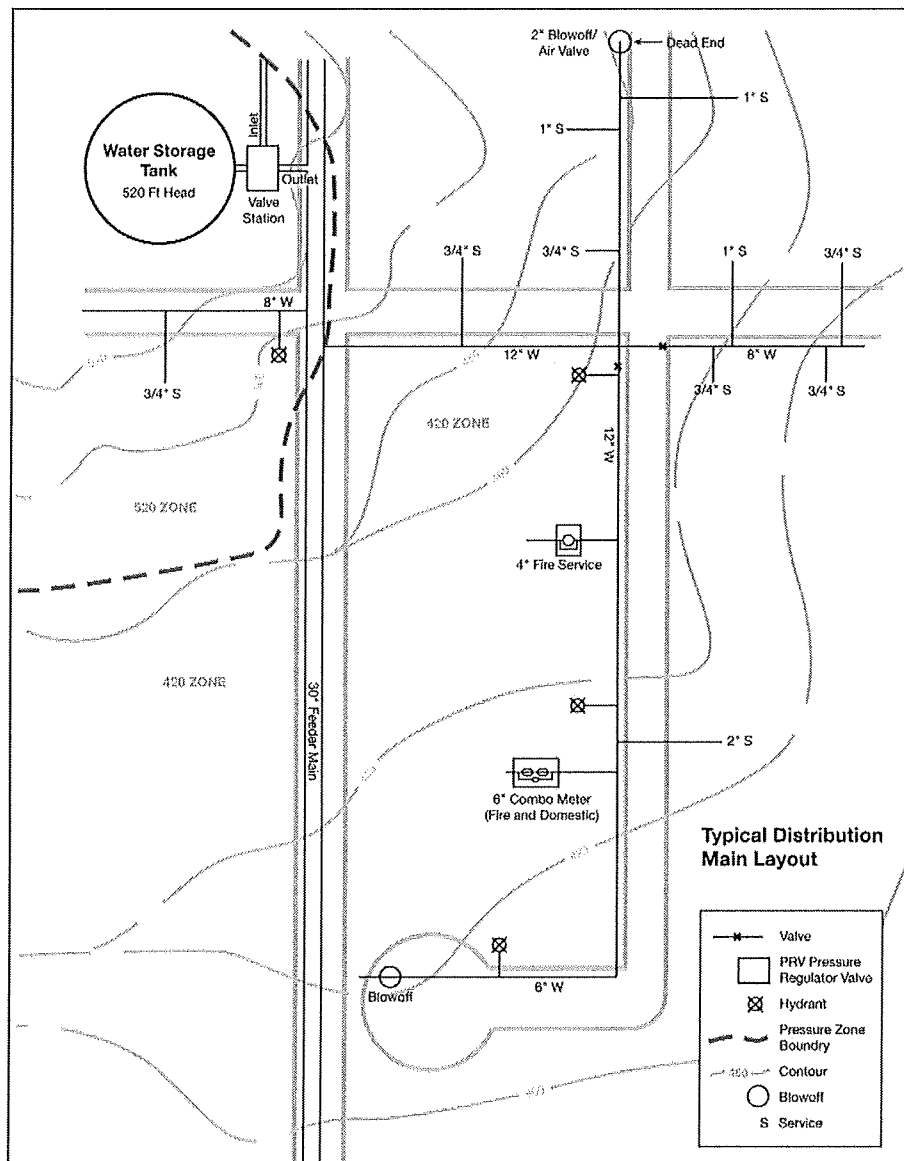
Table 5-1 shows key components in SPU water system infrastructure.

Table 5-1
Key components in SPU water system infrastructure

Infrastructure	Description
Water Main	
transmission main	Large diameter (generally >3 ft) pipeline that transfers water from source to feeder mains or storage tanks. There are no service connections on transmission lines, except for purveyors.
feeder main	Smaller diameter pipeline (generally <3 ft). The backbone of SPU distribution mains. Taps are allowed on feeder mains. Feeder mains may cross through multiple pressure zones. When crossing between zones, no services are allowed.
distribution main	Small to mid-sized pipeline (<2 ft) used to distribute water from a feeder main to a local service area. Distribution mains have service connections to adjacent properties.
Storage Facility	
standpipe	An aboveground supported pipe with a height that is generally greater than the diameter. Used where additional height is needed to provide additional pressure without pumping.
reservoir	Tank that is at or below ground level with a diameter or footprint that is typically greater than the height. Reservoirs are usually large in size and storage capacity.
elevated tank	Elevated tanks have a supporting structure that elevates the lower operating elevation of water in the tank to a level above ground elevation.

Figure 5-2 show the typical layout of SPU water system infrastructure.

Figure 5-2
Typical Layout of SPU Water System Infrastructure



5.2.3.5 Fire Protection

SPU owns and maintains fire hydrants throughout the water distribution system. Fire hydrants are placed as described in section 5.6.4.5. Hydrants are typically supplied by Operations and Maintenance to the contractor for installation. Hydrant model used are typically Kennedy K81D Guardian. No other hydrants are acceptable.

5.2.4 DSG Design Resources

DSG design resources include technical or material specifications developed specifically for and found only in the DSG. They include drawings, standard specifications, and other technical guidelines not available from other sources:

- **Settlement Monitoring Requirements.** Settlement monitoring requirements for water mains are in Appendices 5A and 5B:
 - *Settlement Monitoring Requirements for Cast Iron Mains* ([Appendix 5A](#))
 - *Settlement Monitoring Requirements for Ductile Iron Mains* ([Appendix 5B](#))

5.3 GENERAL REQUIREMENTS

The design engineer must be familiar with water industry standards and code requirements.

If industry standards and City of Seattle requirements or regulations conflict, the design engineer must discuss the discrepancy with the line-of-business (LOB) representative, Operations manager, and the owner of this DSG chapter through the formal resolution process.

5.3.1 Industry Standards

Water facilities must be designed to American Water Works Association (AWWA) standards unless the design engineer can show why the AWWA standards do not meet the project requirements. In addition, water facilities must meet Seattle-King County and Washington State Department of Health (DOH) standards.

Water storage facility design standards for SPU must also meet standards set forth in the Water Research Foundation's Maintaining Water Quality in Finished Water Reservoir.

5.3.1.1 American Water Works Association

Following AWWA standards and specifications is strongly advised where possible, except when superseded by stricter requirements set forth in this DSG and [City of Seattle Standard Plans and Specifications](#).

Table 5-2 lists relevant AWWA standards and specifications, organized by subject and intended as minimum requirements. Most of the specifications listed below may be found in the SMT 45th floor library. It is the design engineer's responsibility to use the latest version of these standards.

Table 5-2
AWWA Standards and Specifications for SPU Water Facilities

Designation	Title
Ductile-Iron Pipe:	
C104/A21.4	Cement Mortar Lining for Ductile Iron (DI) Pipe and Fittings for Water
C105/A21.5	Polyethylene Encasement for DI Pipe Systems
C111/A21.11	Rubber-Gasket Joints for DI Pressure Pipe and Fittings
C115/A21.5	Flanged DI Pipe with Ductile Iron or Gray Iron Threaded Flanges
C116/A21.16	Protective Fusion-Bonded Epoxy Coatings Interior or Exterior Surface DI

Designation	Title
C150/A21.50	Thickness Design of Ductile Iron Pipe
C151/A21.51	DI Pipe; Centrifugally Cast, for Water or Other Liquids
C153/A21.53	DI Pipe; Compact Fittings for Water Service
Steel Pipe	
C200	Steel Water Pipe 6" and larger
C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied
C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied
C206	Field Welding of Steel Water Pipe
C207	Steel Pipe Flanges for Waterworks Service Sizes 4"-144"
C208	Dimensions for Fabricated Steel Water Pipe Fittings
C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipes
C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
C218	Coating the Exterior of Aboveground Steel Water Pipelines and Fittings
C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
C220	Stainless-Steel Pipe, ½" and Larger
C221	Fabricated Steel Mechanical Slip-Type Expansion Joints
C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
C223	Fabricated Steel and Stainless Steel Tapping Sleeves
C224	Nylon-11 Based Polyamide Coating System for the Interior and Exterior of Steel Water Pipe and Fittings
C225	Fused Polyolefin Coating Systems for the Exterior of Steel Water Pipelines
C226	Stainless Steel Fittings for Waterworks Service, Sizes ½"-72"
Valves/ Hydrants:	
C502	Dry-Barrel Fire Hydrants
C504	Rubber-Seated Butterfly Valves
C507	Ball Valves, 6"- 48"
C508	Swing-Check Valves for Waterworks Service, 2"- 24" National Pipe Size (NPS)
C509	Resilient-Seated Gate Valves for Water Supply ductile iron only
C510	Double Check Valve Backflow Prevention Assembly
C511	Reduced-Pressure Principle Backflow Prevention Assembly
C512	Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
C513	Open-Channel, Fabricated-Metal, Slide Gates and Open-Channel, Fabricated-Metal Weir Gates
C515	Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service (Does not meet City Spec, but can be used in special cases)
C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
C540	Power-Actuating Devices for Valves and Slide Gates
C550	Protective Epoxy Interior Coatings for Valves and Hydrants
C560	Cast-Iron Slide Gates
C561	Fabricated Stainless Steel Slide Gates
C563	Fabricated Composite Slide Gates
Pipe Installation:	
C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
C602	Cement-Mortar Lining of Water Pipelines in Place—4" and Larger
C606	Grooved and Shouldered Joints

Designation	Title
C900	PVC Water Transmission & Distribution Pipe
Disinfection	
C651	Disinfecting Water Mains
C652	Disinfection of Water-Storage Facilities
Storage	
D100	Welded Carbon Steel Tanks for Water Storage
D102	Coating Steel Water-Storage Tanks
D103	Factory-Coated Bolted Steel Tanks for Water Storage
D104	Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks
D110	Wire- and Strand-Wound, Circular, Pre-stressed Concrete Water Tanks
D115	Tendon-Pre-stressed Concrete Water Tanks
D120	Thermosetting Fiberglass-Reinforced Plastic Tanks
D130	Flexible-Membrane Materials for Potable Water Applications

Table 5-3 Table 5-2 lists relevant AWWA design manuals for water supply practice. The list is not comprehensive. Some of these manuals are available on SMT 45th floor. The manuals most frequently used by SPU are M11 (Steel Pipe Design), M41 (Ductile Iron Pipe Design), and M22 (Sizing Water Service Lines and Meters).

Table 5-3
AWWA Design Manuals for Water Supply Practice

Designation	Title
M1	Principles of Water Rates, Fees and Charges
M2	Instrumentation and Control
M3	Safety Practices for Water Utilities
M4	Water Fluoridation Principles and Practices
M5	Water Utility Management
M6	Water Meters: Selection, Installation, Testing, and Maintenance
M7	Problem Organisms in Water: Identification and Treatment
M9	Concrete Pressure Pipe
M11	Steel Water Pipe: A Guide for Design and Installation
M12	Simplified Procedures for Water Examination
M14	Recommended Practice for Backflow Prevention and Cross-Connection Control
M17	Installation, Field Testing, and Maintenance of Fire Hydrants
M19	Emergency Planning for Water Utilities
M20	Water Chlorination/Chloramination Practices and Principles
M22	Sizing Water Service Lines and Meters
M23	PVC Pipe Design & Installation
M25	Flexible-Membrane Covers and Linings for Potable-Water Reservoirs
M27	External Corrosion: Introduction to Chemistry and Control
M28	Rehabilitation of Water Mains
M29	Water Utility Capital Financing
M31	Distribution System Requirements for Fire Protection
M32	Computer Modeling of Water Distribution Systems
M33	Flow meters in Water Supply
M36	Water Audits and Leak Detection

Designation	Title
M41	Ductile Iron Pipe Fittings
M42	Steel Water-Storage Tanks
M44	Distribution Valves: Selection, Installation, Field Testing, and Maintenance
M48	Waterborne Pathogens
M49	Butterfly Valves: Torque, Head Loss, and Cavitation Analysis
M51	Air-Release, Air/Vacuum, and Combination Air Valves
M52	Water Conservation Programs-- Planning Manual
M55	PE Pipe--Design and Installation

5.3.2 Regulations

All water facilities must be built to the applicable City of Seattle, King County, Washington State, and federal requirements.

5.3.2.1 City Standards

The City of Seattle Standard Plans and Specifications are available online or from the Engineering Records Vault. The sections that apply to water systems are Standard Specifications Sections 7 and 9, and Details Section 300. These standards are primarily based on AWWA industry standards.

5.3.2.2 City Ordinances

The City of Seattle has a number of ordinances pertaining to the Water System.

5.3.2.3 King County

All water system works are subject to the provisions and requirements of Title 12 of the King County Board of Health Code.

5.3.2.4 Washington State Department of Health

The Washington State Department of Health (DOH) is the regulatory agency that ensures that water systems comply with system capacity requirements of the federal Safe Drinking Water Act (SDWA). Authority to regulate the public water supply system is granted under Washington Administrative Code (WAC), Chapter 246-290 Public Water Supplies, also known as the Public Water System Rule. A key term under the rule is *system capacity*, which is defined as having the technical, managerial, and financial capacity to achieve and remain in compliance with all applicable local, state and federal regulations.

A. Water System Plan

The public water system rule (WAC 246-290) includes the Washington State Legislature-approved Municipal Water Law and the federal law, Long Term 2 Enhanced Surface Water Treatment Rule. DOH requires water purveyors to submit a Water System Plan to ensure water quality and protection of public health (WAC 246-290-100 and WAC 246-291-140, respectively). SPU's Water System Plan was last updated in 2013.

Water systems plans must be updated every 6 years. If a purveyor installs distribution lines or makes other improvements and the project requires State Environmental

Protection Act (SEPA) analysis, a water system plan amendment is required (WAC 246-03-030[3][a]) before construction.

B. Water System Design Manual

The Washington State DOH Water System Design Manual (2013) provides guidelines and criteria for design engineers to use for preparing plans and specifications for Group A water systems, such as SPU, to comply with the Group A Public Water Supplies (chapter 246-290-WAC). This manual delineates mandatory requirements of the WAC that must be adhered to by SPU. Design engineers may use design approaches other than those in this manual as long as they do not conflict with chapter 246-290 WAC. DOH will expect the design engineer to justify the alternate approach used and the criteria that apply.

5.3.2.5 Other

Recommended Standards for Water Works (10-States Standards) – Part 7, Finished Water Storage is a source for water storage design.

5.3.2.6 Federal Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) protects public health by regulating the nation's public drinking water supply. The law requires many actions to protect drinking water and its sources. SDWA does not regulate private wells that serve fewer than 25 individuals. SDWA authorizes the U.S. Environmental Protection Agency (EPA) to set national health-based standards for drinking water to protect against both naturally occurring and human-made contaminants.

5.4 BASIS OF DESIGN

Basis of design documentation communicates design intent primarily to plan reviewers and future users of a constructed facility. SPU accomplishes this documentation through a basis of design plan sheet. By documenting the basis of design and archiving it with project record drawings, future staff will have a better understanding of the design decisions.

5.4.1 Basis of Design Plan Sheet

The basis of design sheet is a general sheet that shows a plan overview and lists significant design assumptions and requirements for major design elements (Figure 5-3). The following are SPU standards for this sheet:

- The design engineer must include a basis of design plan sheet in the plan set.
- The sheet must be archived with the record drawings (as-builts).

Figure 5-3
Basis of Design Plan Sheet Data for Water Infrastructure

Basis of Design Plan Sheet	
WATER-----	
Type of Main (Transmission, Distribution, Feeder)	
Design Flow Rate: _____	
Flow Velocity: _____	
Typical Pressure: _____	Pressure Zone: _____
Working Pressure: _____	Surge Pressure: _____
Pipe Materials: _____	
(type, lining, coating, joints, pressure class minimum slope, buoyancy safety factor, minimum cover [roads, non-roadway], deflection lag factor, construction tolerance, steel deflection limit)	
Bedding Compaction: _____	
(roadway, non-roadway, bedding constant, modulus of soil reaction [E'])	
Appurtenances: _____	
(isolation valves, blowoffs/drains, line valves, air-vacuum and air-release valves, valve limit settings for control valves, design criteria for all valves)	
Access Ports: _____	
Datum: _____	
Basis of HVAC Design: _____	
Basis of Process Control: _____	
Project Specific/Special Information: _____	

The basis of design plan sheet is not intended for construction and should not be included with the bid set. The sheet is inserted after the project has begun. See *DSG Chapter 1, Design Process*.

5.4.2 Design Criteria List

The design engineer may use a design criteria list to develop a basis of design plan sheet. The design criteria list is a shortened version of the most important design requirements (Table 5-3). For water system infrastructure, this information includes how key design criteria were selected, including working pressure, flow rate, and types of joints.

The list shows information that may be shown on the basis of design plan sheet. However, the list is not intended for construction and should not be included with the bid set. If included with the bid set, the design criteria list should be labeled Informational Only.

Typically, the design criteria list is completed with the preliminary engineering report as a concise summary. However, that report can provide a much lengthier description of design requirements.

Table 5-4 is an example of what a design criteria list might contain for a water facility design. *Note that Table 5-4 is only an example; it is not intended to explain technical concepts.*

Table 5-4
Design Criteria List for a Typical Water Facility Design (Example)

Description	Design Criterion/Design Data	Comments
General:		
Design Flow Rate	19,100 gpm	Year 2040 peak flow rate in a 36-inch pipeline
Flow Velocity	6.02 fps	Year 2040 peak flow rate in a 36-inch pipeline
Typical Operating Pressure	120-180 psi	
Design Working Pressure, P_w	250 psi	
Design Transient (Surge) Pressure, P_t	332 psi	Based on 133% of working pressure and allowable stress of 66.7% of yield stress
Minimum D/t ratio	240	
Pipe Materials:		
Pipe Type	Mortar-Lined and Polyurethane Coated Welded Steel Pipe, AWWA C200	
Lining	Cement Mortar, AWWA C205	
Coating	Polyurethane Coated, AWWA C222	
Joints	Restrained Joint	Double lap-welded joint provides thrust restraint at bends, seal testing, and seismic restraint. Maximum joint length and resulting joint location is 60 ft. for steel pipe. Consider thermal expansion and fittings to allow movement, specifically with exposed pipe. Example: pipe supported by hangers under bridges.
Pressure Class	250 psi	40,000 psi yield strength steel
Minimum Slope	0.001	
Pipe Buoyancy Safety Factor	1.1	
Minimum Cover – Roads	3 ft	
Minimum Cover – Non-Roadway	4 ft	
Pipe Loading – Traffic	HS-20 AASHTO	
Traffic – Trench Condition	HS-20 AASHTO Prism Trench design condition assumed	
Separation from Utilities	12 inch vertical, 10 ft horizontal	See Std Plan 286
Deflection Lag Factor, DL	Minimum 1.25	
Construction Tolerance	½-inch from specified line and grade	Tolerances during tunneling higher as specified
Steel Deflection Limit	2.25% of Diameter	
Bedding Compaction – Non-Roadway	90% of Modified Proctor	
Bedding Compaction – Roadway	95% of Modified Proctor	
Bedding Constant	0.10	
Modulus of Soil Reaction (E')	1000 psi	See Geotechnical Report
Appurtenances:		
Isolation Valves	Butterfly Valves, 250 psi rating	Located at tie-ins and interties to existing mains
Blowoffs/drains	6-inch size. Provide at all low points in pipeline	Used double valves, one for isolation and one for throttling.

Description	Design Criterion/Design Data	Comments
Line Valves	2,000 ft	
Combination Air-Vacuum and Air Release Valves	4-inch size. Provide at all high points in pipeline	Also located at abrupt downward grade breaks
Access Ports	24-inch	Located every 1,000 feet along pipeline and at both ends of tunneled crossings

5.5 DESIGN PROCESS

See *DSG Chapter 1, Design Process*. The design process for water infrastructure does not differ from that described in Chapter 1.

5.6 DISTRIBUTION AND FEEDER MAIN DESIGN

This section describes distribution and feeder main design. Distribution mains are smaller diameter (< 3 ft) pipes that carry water from a source (reservoir or tank) to a local service area (neighborhood or city block). Feeder mains are similar to transmission mains except that service connections are allowed.

5.6.1 Modeling and Main Sizing

When designing a water main that is 12 inches or larger in diameter, a hydraulic network modeling analysis must be completed (for minimum sizing criteria see Section 5.6.3.1). SPU Water Planning & Program Management (WPPM) maintains the models of the water distribution and transmission system and works with SPU engineering on modeling analyses. The modeling analysis will determine the capacity of the main to provide peak hourly demand and fire flow. In some cases, field hydrant flow tests will be required to verify modeling results.

5.6.1.1 Pressure Zones

The SPU water distribution system is divided into approximately 45 pressure zones that operate within a pressure range of about 30 to 130 psi. Individual zones are separated by closed line valves (district valves or DVs), pressure regulators, and control valves. Pressure zone boundaries are shown in the 400-foot map books and in GIS. WPPM specifies the pressure zone to which new water mains and service connections will be added.

5.6.1.2 Maximum and Minimum System Pressure

SPU Policy on Distribution System Water Service Pressure (SPU-RM-006) establishes SPU's pressure standards. Minimum pressure criteria for new water mains are 30 pounds per square inch (psi) under peak hour demand (PHD) conditions, and 20 psi when flows are a combination of average maximum day demand (MDD) and required fire flow. Pressure at the customer's meter must not be less than 20 psi. Pressures within distribution mains are not limited to a set maximum. All new services with static pressure above 80 psi require a pressure regulating valve (PR valve) per plumbing code requirements.

5.6.1.3 Fire Flow Rate and Duration

The City of Seattle, City of Shoreline and King County have adopted the International Fire Code (IFC). Site-specific fire flow requirements as determined by the appropriate Fire Marshall are used when issuing Water Availability Certificates and sizing of new water mains.

5.6.2 Location

Distribution mains are typically located within the right-of-way (ROW) in a standard location at a standard depth. See Standard Plan 030. Standard locations allow Operations to easily access the mains while keeping the ROW available to other utilities. SPU does not allow building of structures over water mains without obtaining project-specific concessions from the owner, such as putting the pipe in a casing, O&M easements, or round-the-clock access. These concessions are recorded in the official City records.

SPU may install or allow installation of water mains in private streets or easements. Location of the mains is determined case-by-case in easements less than 20 feet.

5.6.2.1 Separation from Other Utilities

Standard horizontal and vertical separations may not always be feasible in highly developed urban corridors. Special construction methods can be used to provide equivalent levels of protection to the standard separation criteria. Separation distances to provide structurally sound installations depend on the available working space for construction and soils and groundwater conditions at the site. See Standard Plans 286A and 286B.

For overhead clearance, the design engineer must look for overhead power and maintain a safe distance to the power lines and structures. The distance depends on the power line voltage and the distance to a structure. Consult with the electrical utility to determine the project-specific safety distances and with the Seattle Department of Construction and Inspections (SDCI) for any structural permit requirements.

Where standard pipeline separations cannot be achieved, an engineered design must be developed for adequate separation. The Washington State Departments of Health and Ecology jointly publish the Pipeline Separation Design and Installation Reference Guide. The design engineer must consider the contents of this guide while designing water utility separations from other utilities whenever standard SPU criteria are not feasible.

5.6.2.2 Geotechnical Investigations, Test Holes, Borings and Potholes

Geotechnical (subsurface) investigations and test holes are typically not as critical for distribution lines as they are for transmission mains.

Consider geotechnical investigations, borings and test holes where poor soils may influence thrust blocking design, soil loads and settlement of adjacent infrastructure. Furthermore, a cost analysis of moving other potentially conflicting utilities should be made. If the proposed project is expected to incur significant costs to adjust or relocate other utilities, it may be prudent to perform potholing to design the project to minimize the other utility relocation cost. If geotechnical borings or test hole work appears to be prudent, consult DSG section 5.8.2.2 (Geotechnical Report).

5.6.2.3 Alternative Locations

For some projects, space may not be available to locate the water main in the standard location shown on Standard Plan 030. Other controlling factors such as water supply may require that an existing water main be kept in service while a new main is installed in a non-standard location. An alternative to keeping existing water mains in service during construction is the installation of temporary water mains with connections to the affected services and hydrants. This can be an expensive option; cost is usually estimated by Planning & System Support.

5.6.3 Materials

This section describes standard materials used in SPU water distribution system projects.

5.6.3.1 Minimum Pipe Size

The standard water distribution main size is:

- 8-inch-diameter pipe for residential areas.
- 12-inch diameter pipe for industrial and commercial areas.

Other pipe diameters may be allowed at the discretion of SPU, such as where future through connection is not a possibility (permanent dead end main), and the main will never supply a hydrant or more than a few small-diameter water services.

5.6.3.2 Material Types

All new or replaced water pipe in the City of Seattle must meet the standard material types shown in Table 5-4.

Table 5-5
Standard Materials for SPU Distribution and Feeder Mains

Structure	Material
Pipe	• 2 inch diameter pipe (when allowed by SPU) must be Type K copper. • 4 inch diameter and larger pipe must be ductile iron pipe, class 52 or thicker with double thick cement mortar lining. • 4-12 inch diameter pipe can be PVC DR14 on a case-by-case basis in corrosive soil areas. • Feeder mains larger than 12 inch diameter must be ductile iron or steel.
Bends and Fittings	• Typically, bends and fittings must be the same material as the pipeline. • Fittings for 2 inch copper soft coil must be brass, either flared or compression.
Joints	• Joints for ductile iron water mains must be restrained joint (RJ), slip joint (SJ), or mechanical joint (MJ). • Joints on steel pipe must be welded and conform to AWS D1.1 Structural Welding Code, Section 3, Workmanship.
Casing	• Whether installed above grade or below-grade, casing pipe must be smooth steel, with the diameter and wall thickness specified in the drawings. Casings made up of multiple pipe sections must be continuous and butt-welded at joints to provide a uniform surface for casing spacers to slide across. • All joints must be welded by qualified operators. Steel casing pipe is discussed in <u>Std Spec 9-30.2</u>. • Casing seals and spacers must be per <u>Std Spec 9-30(15)</u>.

Structure	Material
	• If specified in the contract, the space between the carrier pipe and casing pipe must be filled with sand, grout, or some other material. However, if the annular space around the carrier pipe is filled, then future removal of the carrier pipe for repair will not be possible. SPU typically seals the ends of the casings but does not fill them.

Non-standard mains less than 8 inches in diameter and approved by SPU, must be ductile iron, except for 2-inch pipe, which must be Type K copper. PVC pipe may be allowed in corrosive soil areas.

5.6.3.3 Pipe Cover

Depths of cover for water mains are shown on Standard Plan No. 030. The depths vary depending on size of pipe. Required cover over gate valves often dictate minimum main cover. Mains larger than 12 inches in diameter typically use butterfly valves. Butterfly valves require less cover due to their shape and allow large mains to be buried at shallower depths. Generally, SPU attempts to bury the pipes as shallow as feasible for ease of installation and maintenance, but no less than 35 inches deep except in special cases as directed by SPU. Typically, the depth to the pipe invert should be kept to less than 6 feet if possible to reduce the need and cost for excavation and shoring.

5.6.3.4 Bedding and Backfill

The design engineer must require sand bedding for water mains unless another agency dictates otherwise. Sand bedding creates a less corrosive environment around a pipe than does native soil. Sand bedding also eliminates point loads on the pipe caused by stray rocks. Sand bedding is typically Class B, Sand Mineral Aggregate Type 6 or 7 unless otherwise specified. (Type 9 is for transmission mains.) See Standard Plan 350 Water Main Trench and Bedding and Standard Specification 9-03.16 Mineral Aggregate Chart

Backfill is either suitable native material, Mineral Aggregate Type 17, or other material as approved by the design engineer. For suitable native backfill material, see Standard Specification 7-10.3(10) for requirements. For requirements for Mineral Aggregate Type 17, see Standard Specification 9-03.16.

For more information on bedding and backfill, see Standard Specifications 7-10.3(9), 9-03.12(3), and 9-03.16.

A. Standard Trench Section

For requirements for a standard trench section, see Standard Plan 350.

B. Controlled Density Fill

Sometimes an outside agency, time constraints, or compaction will require that a water main be bedded and backfilled in controlled density fill (CDF). When this requirement outweighs the benefit of using sand bedding, a metallic water main must be protected where it is embedded in CDF. The protection must extend from trench wall to trench wall. Typically, SPU uses two layers of polyethylene encasement around the main to keep it separated from the CDF (Figure 5-4). The PE encasement is carefully pressed into the soil interface at the trench walls and secured in place with wide adhesive tape or

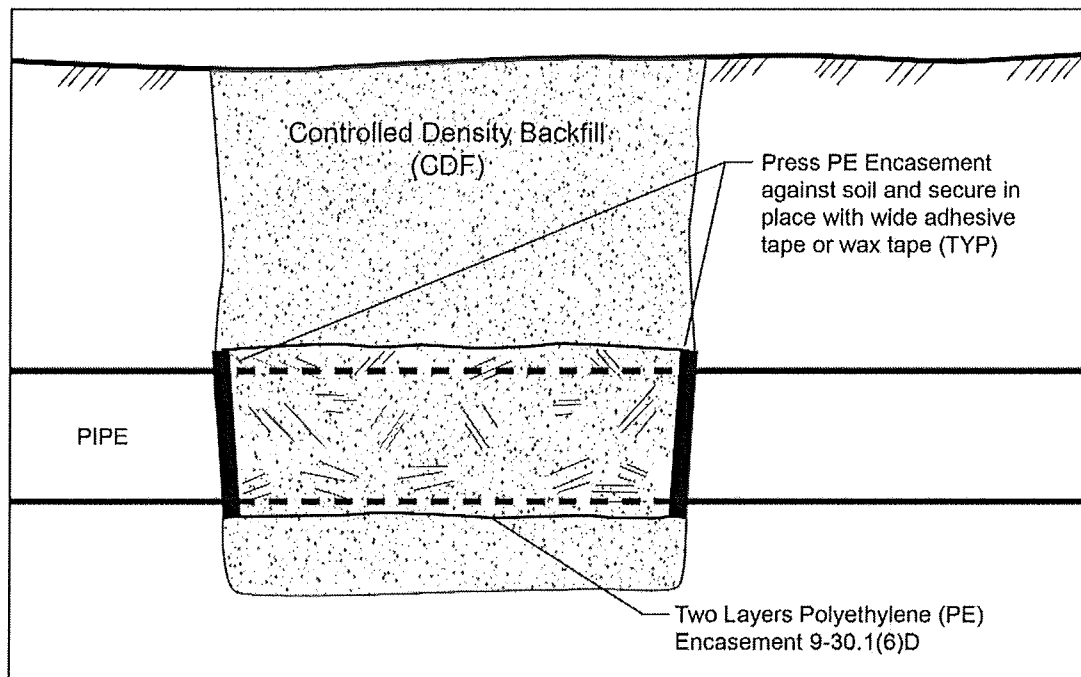
wax tape to ensure the entire metallic pipe is covered and to exclude the CDF from contacting the pipe.

When CDF is used near the metallic pipe, a corrosion specialist should be consulted because CDF can create a galvanic corrosion cell.

The CDF used to encase the water main must be a hand-diggable CDF mix. All CDF must be ½ sack mix, less than 200 psi, and preferably less than 100 psi. SPU has approved various types and uses of CDF. CDF can be used as a trench plug, trench backfill, or for grouting an annular space. Each use has a different mix ratio. The design engineer must reference the City Standard Plans and Specifications for each CDF use. See Standard Specification 9-01.5.

When CDF is used to fill pipe and the annular space between two pipes, it must have 100 psi strength at 28 days. See Standard Specification 9-05.15.

Figure 5-4
Controlled Density Fill



5.6.3.5 Line Pressure

Distribution water mains must be designed to withstand both external loads and test pressure according to Standard Specification 7-11.3(11)A1.

Most distribution lines serve a portion of the city, and are within a designated pressure zone. In cases where there is an extreme pressure differential (e.g. downhill pipeline), it may be advisable to change material thicknesses along the pipeline route and/or install a pressure regulating valve to reduce the pressure. Test pressure is measured at the downhill end of the

pipe run. Before considering installation of a pressure-regulating valve, the design engineer must coordinate with WPPM to ensure the valve will not negatively affect the system.

If a pressure-regulating valve (PR) is used, a pressure relief valve (PRV) must be installed at a location on a major water main within the pressure zone, near the PR valve, at a site which permits the PRV to release abrupt, unmonitored, and unrestricted discharge to a sewer or other permitted location. Pressure relief valves are set to relieve pressures over 80 psi at the lowest elevation within the pressure zone.

Note that some current City zones have pressures up to about 120 psi. Typically, these zones lie at the bottom of steep hillside areas. If the site is steep, do not put a PRV where an uncontrolled release of water from its discharge might cause unstable soil conditions (i.e. landslides). At locations where pressure in the water main exceeds 80 psi, the building code requires homeowners to install a pressure regulator on their service line before it enters the home.

Tip: Consider installing PR valves at the lowest elevation possible. On the other hand, PRVs should be installed as high in the pressure zone and as near the PR valve as possible, to minimize the difference in pressure across the valve. This reduces wear on the PRV seat and leads to better PRV performance and lower pressure surges. Consider also that sites in environmentally critical areas (ECAs) may not be compatible with PRV discharges.

5.6.3.6 Pipe Supports

Pipe supports must be designed under the direction of a licensed civil or structural engineer who is responsible for reviewing pipe loads and potential deflections caused by lateral and vertical movement. AWWA M11 (Steel Pipe Design) and AWWA M41 (Ductile Iron Pipe Design) manuals provide some explanation on how to properly design pipes on supports. The Ductile Iron Pipe Research Association (DIPRA) also publishes a computer program for selecting and spacing supports for ductile iron pipes.

A. Pile Supports

Pile supported pipelines are rare in the SPU water system. However, in some locations, such as crossing a wetland or in loose soils, pile-supported pipelines may be necessary. A licensed civil or structural engineer must design the pile support and calculate pipeline thickness. Because pipelines installed on piles are typically not continuously supported, they present unique design challenges. Among the issues are additional stresses placed on the pipeline due to the lack of support. Such design issues must be investigated and modeled by a licensed structural engineer.

1) Above Grade Pile Support

For an above-grade exposed pile support, the design engineer should consider the pipeline and pile coating system. In most cases, both the pile and pipe will require a coating, and cathodic protection must be considered. Additionally, pipeline insulation may be needed to protect the line from freezing temperatures and in no-flow situations.

2) Buried Support

If the pipeline is on piles and buried, a qualified licensed civil or structural engineer must carefully review the connection to the piles to ensure the pipe and piles operate as one entity during seismic and uplift conditions.

B. Aerial/Bridge Supports

SPU owns and operates a few aerial (aboveground) pipelines in its water system. A structural engineer licensed in Washington State should be involved in aerial pipeline design. Aerial pipelines present unique design challenges because, like pipelines on piles, they are not continuously supported.

Aerial pipelines can either be supported from above, by hanging the pipe, or cradled in a utility corridor under the bridge. In either case, the pipe supports place additional loadings on the pipe wall.

The following are special considerations for aerial design:

- Where possible, aerial pipelines should be avoided for security and vibration concerns.
- When pipes are hung under existing bridges, roadway clearance design must consider the potential for damage from trucks traveling above the legal height limit. Additional protection should be considered such as line valves or structural modifications to the bridge.
- With an exposed pipe design, the design engineer must consider the pipeline coating system. Additionally, pipeline insulation may be needed to help control thermal expansion of the pipeline, and keep the line from freezing temperatures and no flow situations. AWWA Manual M11 provides an analysis method to determine if freezing is a concern.
- The design engineer must carefully review the buried-to-aerial transition to ensure the pipeline will be able to handle ground movement from earthquakes. In most cases, a restrained joint with both rotational and expansion capabilities (e.g. a double ball expansion joint fitting) is recommended. See also [DSG section 5.8.4, Seismic Design](#).
- Freeze protection design must be considered. Potential options include one or more of the following:
 1. Insulation of the pipe;
 2. Heat tape.
 3. In case of a temporary change in the way the pipe is used resulting in low flows consider installation of a system to allow a release of a small volume of water to a location that does not cause an environmental impact or safety hazards

C. Temporary Supports During Construction

Supporting existing utilities during construction can be difficult, but is necessary to ensure no damage occurs to the existing water lines. Typically, the construction contractor is responsible for supporting all existing utilities throughout construction. The contractor must provide a support plan that is stamped by a Professional Engineer licensed in Washington State for review by SPU for approval. SPU engineering and Operations will review temporary supports in the field and notify the contractor of deficiencies. SPU Water Operations staff does not direct repairs.

The following is a list of cautions contractors must take to avoid damage to water lines:

- Contractors must not use chains in direct contact with the pipe to move or support pipe materials because it may damage the pipe coating or introduce point loads that can over-stress pipe.
- Contractors must not rest the pipe on any sharp or pointed objects, including the bucket of any equipment, single point supports, or rods.
- Pipe must not be unsupported for a length longer than one stick of pipe or one joint.
- If the joints are not restrained, the contractor must ensure crew safety by restraining the pipe from movement, which could separate the joints.
- Pipe must be supported in cradles or on wide support beams sufficiently spaced so the pipe does not sag and cause undue stress on the joints or pipe wall. This is especially important for cast iron with lead joints.
- Do not expose more than one unrestrained joint at one time.
- Lead joint cast iron water mains must not be allowed to deflect while they are exposed.

5.6.3.7 Casing

Water mains are installed in casings to protect the mains from excessive loads and to provide a means of replacing the pipe beneath structures such as railroad tracks. Casings also reduce the damage to facilities over the water main in the event of a leak or main break. Sometimes casings are required by other entities (e.g. railroads) where SPU utilities cross over or under them. Casings can be installed via open cut if there are no obstacles.

Casing materials must follow Standard Specifications 9-30.2 (14) and 9-30.2(15).

A. Jacked Casings

Casings installed under the railroad are often jacked into place. When designing jacked casings, adequate space is required for the casing and pipe jacking pit. Jacking pit size can vary depending on the lengths of casing or carrier pipe. Restrained joint pipe must be used through the casing and beyond to a logical location to terminate the restrained joint pipe. Keep in mind that the cased length of pipe offers no thrust resistance via skin friction as does a buried pipe. Access must be provided for the existing pipe to be cut and connected to a new pipe.

***Note:** Jacking casing is dependent on pipe size. The larger the pipe size, the larger the jacking pit is. Consider future access needs for maintenance of the carrier pipe in the casing and try to maintain future access by keeping other utilities away from future access pits.*

B. Other Utility Crossings

The design engineer must determine where casings are needed at locations where an SPU transmission main is crossing either over or under other utilities. For separation requirements between water mains and other utilities, see Standard Plans 286A and

286B. All pipes in casings must be restrained joint. See [Standard Specifications 7-11.3\(6\)D and 7-11.3\(7\)C-D2.](#)

C. Rail Crossings

Where water mains cross under a rail system (e.g. streetcar, light or heavy rail, or other as determined by SPU), the main must be placed inside a casing. The casing must extend such a distance from the tracks that maintenance can be performed from the side without affecting the rail. For cathodic protection for pipes crossing a rail line, see [DSG Chapter 6, Cathodic Protection](#), Test Procedure 31 – Light Rail and Streetcar Cooperative Interference Testing.

1) Heavy Rail

When crossing beneath heavy rail, a casing must extend from ROW line to ROW line unless the main is more than 25 feet from the track centerline. If the railroad agrees, the casing must extend a minimum of 25 feet from the track centerline. See the [American Railway Engineering and Maintenance-of-Way Association \(AREMA\) Design Guideline](#) before designing a heavy rail crossing.

Pipelines parallel to heavy rail must be encased if they are 40 feet or less from the track centerline.

2) Light Rail

Light rail does not impose the extreme loading on pipelines that heavy rail does. However, light rail imparts some loading and causes significant pipeline access issues and stray current corrosion concerns.

Water mains crossing beneath Sound Transit Central Link light rail tracks are encased a minimum distance of 12 feet perpendicular to the centerline of the track. The tracks have a 5-½ foot minimum separation between the top of the rail and the top of the casing. See the [Sound Transit Design Criteria Manual](#).

Casings crossing a light rail line must be electrically isolated from the carrier pipe. A permanent test station should be installed to perform future isolation checks. See [DSG Chapter 6, Cathodic Protection](#), Test Procedure 31 – Light Rail and Streetcar Cooperative Interference Testing.

3) Streetcar

The presently used streetcar designs have the least impact on buried pipelines of the three types of rail. Streetcars are smaller and lighter, but still limit pipeline access and generate stray current.

The design engineer must consider depth of cover, pipeline size, age, thickness, material, importance, and access.

The design engineer should consider various pipeline protection methods ranging from do nothing to casings and protective concrete slabs.

D. Parallel Rail Installations

For worker safety, parallel mains should not be closer than 15 feet from the rail centerline. However, rail installation will likely have to be considered case by case.

5.6.3.8 Permanent Restraint Systems

Restraining of forces due to internal pressure at fittings, valves, or dead ends is a major consideration in pipe installation. Thrust restraint is by welded or mechanically restrained joints and/or concrete thrust blocks that are either cast in place or pre-cast depending on pipe size and type.

All bends, fittings, and line valves must be restrained by a joint restraint system compatible with the pipe type.

A. Thrust Restraint Calculations

For all projects requiring thrust restraints beyond that required by Standard Plans 330a, 330b, 331a, and 331b, the design engineer must calculate the thrust restraint forces and design the restraint system.

Restrained joint pipe is self-restrained. The restrained length for pipe and fittings depends on the test pressure, backfill, depth, soil characteristics and pipe coating. The design engineer must calculate the restrained length for both pipe and fittings.

B. Connecting to the Existing System

In the SPU water system, most connections to existing (non-steel pipe) are unrestrained. A difference in outside diameters of various materials can create a force imbalance at the connection similar to that of a reducer.

For example, a 100-year-old cast iron, 20-inch diameter water main could be ½-inch greater in outside diameter than a new 20-inch diameter ductile iron main. This force imbalance must be accounted for at the connection, especially if corrosion preventative isolation couplings are used to make the connection. At 100 psi, this difference in outside diameter creates a force imbalance of more than 3,000 lbs in a 20-inch-diameter pipe connection. The connection coupling can be restrained by using tiebacks, wedge restraint glands, or welded tabs on the smaller pipe, or some combination. The idea is to keep the connection coupling from sliding off the larger pipe and onto the smaller pipe due to the force imbalance.

Be careful with restraint for new valves near connections to existing pipe, especially when new restrained joint pipe is connected with unrestrained pipe. When closed and under pressure only from the existing side, the valve will tend to collapse the new flexible restrained joints and pull away from the unrestrained connection. This effect is usually overcome with a concrete thrust collar on the new pipe that is fixed rigidly to the new valve.

5.6.3.9 Types of Pipe Restraints

This section describes the types of pipe restraints used in the SPU water distribution system. Typically, ductile iron pipe is joined by a non-restrained bell and spigot joint, also called a Tyton or push-on joint. Some steel pipe is also joined in this manner. Thrust blocks are the SPU standard for restraining pipe when non-restrained bell and spigot joints are used. The design engineer should use Standard Plans 330a, 330b, 331a, and 331b and the AWWA Manual M41 to design thrust blocks. Some situations will not allow space for concrete thrust blocks. In those situations, use pipe with built-in restrained joints, or pile supported thrust restraint systems.

A. Concrete Blocking

Concrete thrust blocks are the most common joint restraint in the SPU system. Thrust blocking relies on the surface area of the block being in contact with undisturbed soil to counteract the pressure acting on the pipeline fitting. Conditions may require a pile-supported thrust restraint system. The soil conditions are a very important factor in concrete thrust block design.

In concrete thrust block design, excavations or disturbance of soils behind thrust blocks should be avoided. An assessment should be performed by a qualified engineer to determine if there is a safe distance away from the thrust block that an excavation could be performed.

During design, consider future disturbance of thrust blocks

1) Horizontal Thrust Block

Horizontal thrust block sizing calculation must follow either Standard Plan 331 or AWWA Manual M-41.

2) Vertical Thrust Block

In some cases, vertical thrust blocks may be needed. Vertical thrust block must follow Standard Plan 330.

B. Concrete Thrust Collars

Concrete thrust collars are occasionally used as a method of thrust restraint. Typically, thrust collars are used to restrain large valves in chambers and valves near casings or connections to existing pipe. Collar refers to the section of concrete formed around the pipe to counteract thrust forces. Collars withstand thrust force by both passive soil pressure and friction on the bottom surface of the block. To keep the pipe from sliding within the collar, the concrete needs to interface with the pipe.

1) Steel Pipe

If using concrete collars on a steel pipe, a factory installed or field welded thrust ring must be welded around a pipe section, then embed in concrete. This design should be thought out to make sure that the interior of the pipe coating is not damaged due to the high heat from welding before the pipe is put in service.

2) Ductile Iron Pipe

If using concrete collars on ductile iron pipe, the preferred method is to have a factory-fabricated thrust ring installed on the pipe section. Otherwise, install two wedge restraint glands (WRGs) face-to-face to act as a thrust ring. Concrete-encased WRGs should always be wrapped in polyethylene so the concrete does not seep into the restraining wedges and stop it from working.

3) Poor Soil Conditions

Design should consider the potential settlement impact the concrete thrust collar could have on the pipe.

C. Pipe Anchors/Tie Backs

Pipe anchors consist of a large mass of concrete usually on one side of a pipeline. The concrete is attached to the pipeline by steel rods. Anchors act like vertical thrust blocks (except in a horizontal plane) to restrain the pipe at a bend. Typically, pipe anchors are only installed for temporary service because the rods can corrode.

D. Rigid Restrained Joints

Flanges, welded joints, and threaded couplings are types of rigid restrained joints. Flanges can be used on both ductile iron and steel pipes. SPU does not use threaded couplings in water mains.

1) Flanges

SPU does not recommend burying flanges in soil. Flanged fittings are used where joint flexibility is not needed and are typically found in vaults associated with valves or other appurtenances. Flanged pipe must be installed perfectly to fit up and offers no flexibility. A dismantling joint must be used to allow disassembly and repairs. Flanged valves are usually used with in the installation of a large run of flexible restrained joint pipe. Each flanged valve will have a short flange by flexible restrained joint adapter on each side of it.

Manufacturers can weld a flange to the steel pipe. See AWWA Manual M-11 for the class of flange rating. Consult with the manufacturer to ensure the flanged connection can be provided. An electrical isolation kit may be necessary if joining the steel pipeline to a ductile iron appurtenance. Steel and ductile iron are dissimilar materials that can corrode.

2) Welded Joints

Steel pipe can be assembled with welded joints, making the pipeline fully restrained. Field-welded joints provide restraint against the unbalanced hydrostatic and hydrodynamic forces acting on the pipe. There are several styles of welded joints. The most common are the lap-weld, butt-weld, and butt strap joints. Refer to AWWA Manual M-11 for a photo of each type of joint:

- **Lap-Weld Joint.** In general, SPU prefers a lap-weld joint because they are easy to install. Lap-welded pipe is a bell and spigot pipe with the bell welded to the spigot where they overlap. The design engineer can select an interior-only weld, exterior-only weld, or double lap weld (interior and exterior). SPU recommends the double lap weld. A double lap weld provides an added safety factor at each joint, but can only be applied to larger diameter pipe because it requires the welder to enter the pipe to make an interior weld. Each joint can also be checked for leakage with an air test. With a lap weld joint, small deflections can be made at each joint before welding. Given the geometry of the double welded lap joint, it experiences twice as much strain as the pipe wall when post-construction forces (settlement) cause pipe movement.
- **Butt-Weld Joint.** Butt-weld joints are made by aligning the ends of two pipe sections and welding at the point of near-contact of the two ends. To complete a butt-weld joint, both ends of the pipe must be the same size. A butt-weld joint is more difficult in the field because the pipes must be near perfectly aligned.

This style weld eliminates the geometric strain that can be induced at a lap-weld joint. SPU has used butt-welded joints for pipelines designed for higher levels of seismic loading. The butt-weld joint is also used in horizontal directional drilling (HDD) applications, where having a bell shape on the pipe is not recommended. A full penetration butt-welded steel pipe is one of the best choices for seismic protection.

- **Butt-Strap Joint.** A butt-strap joint consists of a strip of steel that overlaps two plain end pieces of pipe by several inches. The butt strap is joined to each pipe by an exterior weld (and an interior weld if the pipes have sufficient diameter). The two pipe ends do not have to have identical outside diameters, but they must be relatively similar. Typically, a butt-strap joint is used to join a new steel pipe to an existing steel pipeline.

In all cases, repair of the interior lining must be considered at the welded joints. SPU follows the recommendations of the American Welding Society (AWS) Structural Welding Code.

E. Flexible Restrained Joints

Flexible restrained joints allow some deflection and movement of the joint, but restrain the joint while under pressure. These joints are the standard restrained joints used by SPU. All ductile iron pipe manufacturers make a boltless restrained joint ductile iron pipe that uses a restraining ring and locking lugs to restrain joints yet provide flexibility. Check the manufacturer's literature because products vary.

The use of flexible restrained joint pipe systems should be used when special site or system conditions are present and the use of concrete thrust blocks is not appropriate. Flexible restrained joint pipe systems are required when site/project needs have the following characteristics:

- The water main is to be located in an area of liquefiable soils.
- The area is defined to have soils with a poor bearing capacity.
- The area is on a steep slope and particularly if the water main is to be in an area determined to be a slide area.
- If the site is congested with underground utilities or other facilities such that concrete thrust blocks are unfeasible.
- To provide flexibility in shutdown areas and avoid using temporary thrust restraints.
- In areas where excavations, soil settlement or subsidence is anticipated, restrained joint pipe should be considered.
- In pipelines critical to the functioning of the water supply system after a major seismic event.

Restrained joint pipe and fitting pressure ratings vary depending on fitting type and size. The pressure ratings must be verified with the manufacturer. The length of pipe in casings on any run of ductile iron pipe does not count towards its overall restraint length, unless the casings are filled with grout after the pipe is installed. When using restrained joint pipe, all pipe in each individual system must be restrained joint. In

addition to pipe joint restraint, it is SPU practice to install concrete thrust blocks unless site-specific conditions do not allow their use due to space limitations or other conflicts. Prior approval of the engineer of record is required before the thrust block is eliminated.

1) Wedge Restraint Glands

Other examples of flexible restrained joints are a wedge restraint gland type device or a restrained gasket type of pipe. Wedge restraint glands must follow Standard Specification 9-30.5(5)B. Wedge restraint glands are typically used on mechanical joint pipe and fittings; they grip the pipe, which forces a lug with teeth to imbed into the pipe. Most wedge restraint systems remain flexible after installation.

***Note:** SPU has experienced some expensive failures due to inappropriate application of wedge restraint glands. Two significant situations must be avoided:*

Wedge Restraint Glands are not approved for use on plain end (PE) fittings. Ductile iron fittings go through a casting process that makes their outside surface much harder than ductile iron pipe. As a result, the restraining wedges do not bite into the surface of plain end fittings to the proper depth. While the initial testing of these joints might prove successful, over time, the joint may separate.

Wedge restraint glands must not be used in applications where they are expected to resist rotation of the joint in addition to tensile pullout. If a rotating moment is applied to the joint, the restraint wedge teeth slide along the pipe with little resistance and allow the pipe to corkscrew out of the MJ socket. Therefore, all rotating moments must be properly blocked or otherwise restrained when wedge restraining glands are used.

2) Gasket Restraint

The restraint gaskets are readily available and can be installed on field-cut push-on joint pipe. The restraining gaskets have stainless steel teeth imbedded in them that grip the pipe for restraint. The restraint gaskets are only pseudo-flexible restrained joints. Once assembled, they offer little or no deflection capability. They also require special tools to disassemble.

***Note:** SPU has used the restraint gaskets on occasion, but found they do not save costs. The AWWA M41 Manual or DIPRA computer program can be used to calculate ductile iron pipe restraint requirements.*

Field cutting and modifying a factory restrained joint pipe is difficult and time consuming. The pipe must be ordered specific to the project site. Contractors must submit and receive approval of a lay plan showing both plan and profile before ordering pipe.

3) Grooved Restraint

Grooved restraint couplings can be used to restrain ductile iron and steel pipe. These couplings are uncommon in the SPU system but can be found on some blowoff facilities. Grooved restraint couplings are generally not used in buried service.

The standard grooved restraint coupling engages a groove that is cut on the exterior of the full circumference of the pipe. An AWWA ductile iron pipe class thicker than SPU's standard CL 52 must be used for these couplings.

Grooved restraint couplings can also be used with a rolled groove in thin wall steel pipe and with a welded end ring on both ductile iron and steel pipe. Flexible steel restrained joints come in the form of a coupling that connects two pipe sections. The restraint is obtained by grooves on the coupling engaging a steel rod that is welded to the outside of the pipe. These couplings are custom designed to each project and can be ordered with some minor expansion capability. While quick and easy to install, grooved restraint couplings are expensive. One manufacturer is Victaulic brand.

For how to design restrained joint pipe systems without concrete blocking, see the Ductile Iron Pipe Research Association (DIPRA) program.

F. Flexible Single-Ball and Double-Ball Expansion Joints

For projects where extreme flexibility is needed, several manufacturers offer river crossing pipe that has restrained, ball joints that provide a high flexibility in alignment. Another flexible product is a single or double-ball expansion joint, which is very expensive. The double-ball expansion joint can rotate, extend, contract, and adjust in any direction, yet will not separate. However, improperly installed expansion joints can expand unintentionally under pressure. The design engineer should use care in designing expansion joints in the pipe system.

At a location on each side, the pipe must be fixed by a thrust collar or other means to keep the expansion joint from moving. At least one fitting manufacturer makes a force-balanced version of the expansion joint to use in locations where thrust collars are impractical or impossible to install.

5.6.3.10 Temporary Restraint

Temporary restraint is sometimes required during construction to restrain pipe thrust forces usually where the pipe has been cut and capped and a dead end is created. Temporary restraint comes in several different forms, and is usually installed before other work so that the pipe can be cut, capped, and turned back on in a single outage. In smaller diameters, a precast concrete block (Ecology block) is usually placed in front of the cap to act as a thrust block. In larger diameters, a tieback system is usually used where steel rods connect the cap to an anchor (usually two precast concrete blocks) and sometimes piles. On projects where the contractor must furnish temporary restraint for situations not covered by Standard Plans 330 and 331, the contract drawings must show a typical restraint detail, without design specifics, that has clear instructions directing the contractor to submit a design stamped by a licensed engineer to SPU for approval.

5.6.3.11 Chambers (Vaults)

Terminology: Standard Specification 9-30.3(12) refers to valve chambers for material specification for bidding purposes. The Standard Specifications also refer to “electrical vaults” in Sections 1-05.2(2) and 1-07.28 paragraph 8)a and elsewhere and SCL projects will refer to electrical vaults. Functionally, chambers and vaults are the same. Namely, they provide an access space around buried equipment for room to operate or maintain the enclosed equipment. If vault terminology is used on plans, it must be tied to the bid item terminology called chambers to be unambiguous.

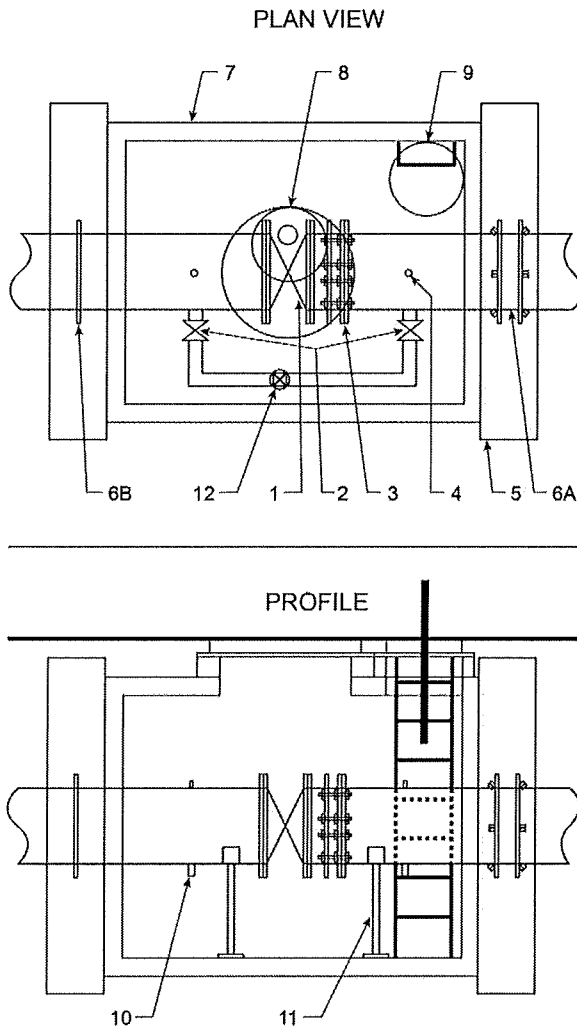
Valve chambers are required for all water system valves 16 inches and larger, for valves that separate service pressure zones (district valves) and for all buried installations that have electrical service and electronic sensors. Chambers are also provided for transmission main blowoff valves, large orifice air and vacuum valves, PR valves, PRVs, and check valves. Chambers are also provided for water services that are larger than 2 inch, and for all water services to purveyor meters.

Chambers that have electricity or electrical equipment must be drained. Either gravity drains or sump pumps may be used depending on site availability. Provide a sump with a galvanized metal grate to cover the sump.

Provide 18 inches of clear space around piping and equipment for access and maintenance. Where space is tight, provide no less than 18 inches on one side and no less than 12 inches on the opposite side. There must be enough room to access all bolts and fastening hardware and to remove cover plates on valve actuators and valve bearings and seals. For PR valves and PRVs consult the manufacturer's literature for clearances on each side of the valve and overhead needed to remove the valve bonnet and pilots for maintenance.

Where possible, locate chambers out of roadway surfaces. Provide an equipment access over heavy equipment and a personnel access to all locations inside the chamber. Access openings should be 24 inch diameter or larger. 30-inch diameter or 3 ft square is the preferred chamber top opening for personnel access. Cover access openings with 3 ft square or larger hatches if out of the roadway, and with Standard Plan 361 Ring and Cover with adjustment brick and mortar for chamber access in roadways. Provide floor-supported ladders with ladder safety extensions having a 3 foot height, or more, above ground for all personnel access openings. Where internal equipment is larger than the 24-inch or 30-inch opening, consider how the internal equipment can be replaced, and the impacts to paving if the vault top has to be removed to do so.

Figure 5-5
Typical Layout of a 16-inch or Larger Line Valve



NOTES:

1. 16"-30" LINE VALVE (SHOWN AS FLXFL)
2. BYPASS VALVE (TYPICALLY 4"), FL X MJ, WITH OP NUT EXTENSION AND VALVE BOX
3. FLXFL DISMANTLING JOINT
4. AWWA X IPT CORPS ON EACH SIDE OF VALVE, ON TOP AND BOTTOM IF LEVEL FOR AIR FLOW AND DRAINING, OR ONE ON TOP ON LOW SIDE OF VALVE AND THE OTHER ON BOTTOM ON HIGH SIDE OF VALVE IF PIPE IS SLOPING
5. REINFORCED CONCRETE THRUST COLLAR (GENERALLY NOT NECESSARY ON WELDED STEEL PIPE)
- 6A. BACK TO BACK OPPOSING WEDGE RESTRAINT GLANDS POLY BAGGED (OPTION A) (NOT APPLICABLE TO WELDED STEEL PIPE)
- 6B. WELDED STEEL COLLAR (OPTION B) (GENERALLY NOT NECESSARY ON WELDED STEEL PIPE)
7. PRECAST OR CAST IN PLACE CHAMBER. IF CAST IN PLACE, THRUST COLLARS CAN BE INTEGRAL TO CHAMBER.
8. 42" RING AND COVER WITH 24" INNER COVER. CENTER 42" COVER OVER VALVE AND 24" COVER OVER VALVE OPERATOR.
9. 24" RING AND COVER AND LADDER FOR ACCESS
10. AWWA X IPT CORP ONE EACH SIDE OF VALVE, BOTTOM OF PIPE
11. PIPE SUPPORT STAND TYPICAL OF 2.
12. TEE WITH OUTLET TURNED DOWN AND PLUG IN OUTLET. ALL BYPASS PIPING TO BE MJ W/ MEGA-LUGS

GENERAL NOTES:

- A. DESIGNS WILL VARY DEPENDING ON PIPE TYPE (DUCTILE VS STEEL) AND JOINT TYPE.
- B. SIZES OF ALL VALVES SHOWN CAN VARY DEPENDING ON LINE VALVE SIZE AND USE.
- C. CHAMBER SIZE AND PIPE ALIGNMENT WITHIN THE CHAMBER WILL VARY DEPENDING ON SITE CONDITIONS.
- D. FOR CLARITY, NOT ALL PIPE JOINTS ARE SHOWN. A PIPE JOINT SHOULD BE INSTALLED OUTSIDE THE CHAMBER WITHIN A FEW FEET OF THE THRUST COLLARS WHEN USING FLEXIBLE JOINT PIPE.
- E. DISMANTLING JOINTS DO NOT RESTRAIN PIPE IN COMPRESSION. IF CHAMBER IS PART OF LINE VALVE THRUST RESTRAINT, IT MUST BE CAPABLE OF TRANSFERRING THE THRUST. TYPICALLY, CHAMBER WALLS ARE DESIGNED WITH LIGHT DUTY WIRE FABRIC REINFORCEMENT AND ARE NOT DESIGNED TO TAKE THRUST LOADS.
- F. PLACE PIPE SUPPORTS UNDER BOTH BYPASS AND UNDER TEE.

5.6.4 Appurtenances

Pipeline appurtenances (line valves, access ports, blowoff/drains, and air release/air vacuum valves) must be provided along the pipeline as needed to support the pipeline function and operation. Appurtenance locations should be determined during design and consider conflicts

with other structures, vehicular traffic, and existing utilities. Appurtenance locations should avoid areas most vulnerable to damage or vandalism.

5.6.4.1 Valves

When a distribution main, feeder main, or pipeline requires a valve, note the function (use) of the valve when selecting the type (physical design and characteristics) of the valve. The valve's function, type, and nominal diameter will have a bearing on additional requirements for the overall valve assembly. Note provisions specifying instances in which a valve bypass assembly or maintenance vault is required. Pay close attention to maintenance clearances, dismantling features, and other details included in the requirements for more complex valve installations.

The number of turns to close a valve is very important. Rapidly closing a valve can create a surge pressure wave (water hammer) in the pipeline and damage the line and appurtenances. See Standard Specification 9-30.3(4).

A. Principal Valve Functions within the Water System

Broadly speaking, there are four types of valve functions: Non-Modulating (non-throttling) valves, Modulating (throttling) Valves, Check (non-return) Valves and Air Valves. Examples of how these functions are incorporated into the water system are presented below together with the related hardware selection criteria.

1) Non-Modulating (non-throttling) Valves

Non-Modulating (non-throttling) valves remain in either a normally open or a normally closed position. They are changed to the opposite position when needed to perform their function. Non-modulating valves are typically thought of as manually actuated by either turning the operating nut on the valve using a gate key, or by manually operating the valve using a powered valve actuator through a switch or SCADA control. Non-modulating valves are rarely set in a partially open (or closed) position except for situations where the pressure downstream is less critical than restricting the flow rate into a portion of the water system.

An example of partially open non-modulating valves would be providing reduced service to customers in a portion of the water system located in an actively unstable soil situation (like landslides). In this situation, a non-modulating valve that is normally open will be closed enough to allow only a small domestic supply to feed the area. Fire supply is greatly limited and is only possible by re-opening the valve. This partially open position limits the amount of water that can escape in the case where the unstable soil moves and causes the water main to separate. The partially open condition is only temporary until the soil (or other issue of concern) is stabilized.

Line valves are used to isolate segments of the water distribution grid, the feeder network or transmission pipelines. The normal position for a line valve is fully open, with the valve being moved to a fully closed position to stop flow through (or section off) that portion of pipe. If all line valves to a run of pipe are closed, the main can be drained for new construction or repair activities while limiting the water outage to only a small subset of the local customers. The section titled *Valve Placement Strategy within the Water Distribution System* outlines guidance for how line valve locations are selected to allow both flexibility of operation and a minimum of disruption to our customers during water main shutdowns.

Line valves are typically either gate or butterfly valves, depending on pipeline size. Ball and plug valves may be used in the following situations: high pressure (± 250 psi), significant throttling under high flow rates, control of pressure surges, or where throttling of high pressure differentials may be required.

Gate valves are preferred for line valves where possible. They completely exit the flow path when fully open and allow drained water mains to fill without bypasses. However, gate valves require space for a valve bonnet above or to the side (laydown valves) of the pipeline. Cover over water main may be critical. In cases where substandard cover is allowed, the gate valve operating nut must be below the bottom of the paving. This is particularly sensitive for concrete pavement, which tends to be thick. Gate valves are typically more expensive than butterfly valves. Laydown valves must be operable from the street surface and require a sealed right angle gearbox.

Butterfly valves are frequently used on larger pipelines. All valves 16 inches and larger should be full-size inline butterfly valves and be installed in chambers. Standard practice for valves under 16-inches is to use gate valves, but butterfly valves can be used where gate valves will not fit. Butterfly valves 16 inches or larger must be installed with a bypass to allow a drained pipe to fill without throttling the butterfly valve seats. Throttling of large-diameter butterfly valves is a primary reason seats have been destroyed after only one or two uses. Make provision for replacement of butterfly valves in the chamber design. Include a dismantling joint, or similar, to enable disassembly of the pipe and design chamber to accommodate replacement.

Isolation valves are non-modulating valves that are used to section off or partition a distribution grid or pipe within a common pressure zone. Applications may include maintaining seasonal water supply regimes and limiting the risk posed by threatened water mains. The separation provided by Isolation valves is significant in the way it alters water circulation through a pressure zone. Unlike a district valve (see next section), an isolation valve can be opened without causing harm to the water system or customers and opening it removes the partitioning operation for which it is designed.

The term isolation valve is also used for valves installed on both sides of appurtenances such as pumps, modulating valves, and meters, which must be periodically removed from service for inspection or maintenance.

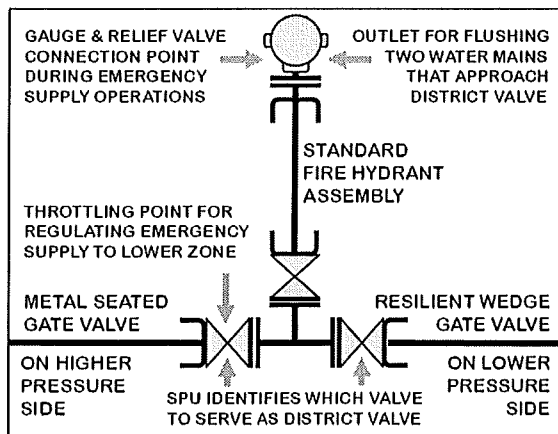
District Valves (DVs) are non-modulating valves that are used to section off physically connected pipe into discrete water pressure service areas (pressure zones.) District Valves have an advantage over physical pipe separation as a means of demarcating adjacent pressure zones. District Valves exist to reserve the option of temporarily realigning a pressure zone boundary, or to allow one zone to supply its neighboring zone under certain emergency conditions. However, a district valve may remain in the closed position for decades.

Because DVs effectively creates two dead ends, DVs should be located adjacent to a fire hydrant whenever possible. Typically, a district valve will be positioned on the water main to one side of an adjacent hydrant tee and a second (line) valve will be located on the water main to the opposite side of the hydrant tee from the DV, (see figure below). This arrangement allows the two water main segments approaching the closed district valve to be flushed in separate operations. The fire hydrant provides a discharge

capacity that ensures effective flushing velocities. The hydrant also facilitates pressure management and overpressure protection during emergency throttling operations at the DV. SPU will determine which of the two valves at the hydrant tee will serve as the DV.

Regardless of the DV designation, the valve placed on the higher-pressure side of the hydrant tee should be a metal seated, double disk gate valve (DDGV). Whether or not the DDGV is designated as the normally closed district valve, it will serve as the throttling valve during emergency supply operations requiring the higher-pressure zone to feed the lower pressure zone. Advance planning may be required to obtain DDGVs because there is only one manufacturer that still makes these valves in the 4 inch through 12 inch sizes and the production run is typically on a once per year basis for SPU's annual purchase of them. Very long lead times should be expected if a contractor is required to furnish them.

Figure 5-6
Pressure Zone Boundary District Valve Co-Located with Fire Hydrant



When placement of a district valve adjacent to a fire hydrant is not possible, a 2-inch outlet on both sides of the district valve is required to allow flushing of the water main segments approaching the DV. Typically, corporation stops are used, and are positioned at the crown of the pipe to assist in air and vacuum relief during a shutdown. A vault must be provided for the district valve and flushing outlets to allow hose connections if the outlets are not otherwise permanently piped to an access hand hole.

Service Supply Valves and Branch Supply Valves are similar, as they permit the supply of water from a distribution water main to be shut off to a metered water service or to another unmetered lateral (branch) such as a fire hydrant branch, or water main stub installed for future extension. Service supply valves and branch supply valves are typically installed and tested as part of a new water main's construction. Hydrant branches, 3 inch and larger water services, and headers supplying remote water services are normally constructed off service supply valves and branch supply valves attached to the water main.

Blowoff Valves: SPU maintains 4 inch and larger valves at the low points of transmission mains and feeders that permit draining those large-diameter pipes down to their inverts. SPU also maintains 2 inch and smaller valves attached to 8 inch and smaller dead end distribution mains for flushing those mains. The valves for these two relatively different functions are referred to as blowoff valves.

- **Large Pipe Draining:** Blowoff valves are located at the low points along a larger-diameter (> 12") feeder or transmission mains. They primarily exist to drain the pipe during a shutdown. A blowoff valve installation on large pipes requires an assembly that includes two valves in series. The valve connected directly to the feeder or pipeline is reserved for leak-tight sealing of the blowoff outlet. It is the blowoff isolation valve. The second valve, sometimes referred to as the sacrificial valve, performs the actual water discharge control, often at high pressure differential. The second blowoff valve is manually operated in a partially open position as a variable orifice in order to throttle the flow rate to an acceptable level. Replacement of the sacrificial valve, due to wear or damage during blowoff operations is enabled while the pipeline is in operation because the isolation valve is closed. Always provide a fitting such as a dismantling joint, or a piping arrangement such as a 90° bend adjacent to the sacrificial valve that allows the piping to be dismantled in order to replace the valve. Blowoff valve systems on transmission lines are usually deep and are installed within a blowoff chamber for easy maintenance access and they have their operating nuts accessible from the ground surface.

Since blowoff valves usually discharge to atmosphere, their operation, can involve moderate to extremely high pressure differentials, especially when maintaining the valves while the water main is in service. Regular maintenance includes opening them a little to flush the piping and closing them again while the main is in service. This is a procedure called exercising the valve. For high pressure applications, above ± 200 psi, the preferred valve type is a lubricated plug valve. For pressures at ± 200 psi or less, a gate valve is preferred. In cases where retrofit of existing isolation valves is required and a plug valve cannot be reinstalled, a high pressure butterfly valve (AWWA CLASS 250) can be used. Some butterfly valve manufacturers can make butterfly valves rated as high as 350 psi. Butterfly valves are never to be used as the sacrificial valve.

Following the sacrificial valve, a riser brings the discharged water to an air gap at the surface. Blowoff draining flow rates are limited by the receiving utility or water body. A tap to add sodium thiosulfate or ascorbic acid for dechlorinating water can be provided at the blowoff, but this is not common. De-chlorinating chemicals are often added at the air gap structure under atmospheric pressure conditions.

All blowoff outlets must have an air gap (see section 5.6.4.3) between the pipeline discharge point and the ground (or surface water elevation of the receiving body) equal in length to a minimum of two discharge pipe diameters. See example plans in the Virtual Vault 776-227 and 776-203. Both show examples with sacrificial throttling valves. Example plan 776-203 also shows a special condition where water is transferred to another pipeline through a pipeline-to-pipeline pumping connection.

- **Small Pipe Flushing:** Blowoff valves located at the dead ends of distribution mains are provided in the form of smaller diameter laterals, typically consisting of 2-inch copper tubing. For detail on design of small blowoff valves, see Standard Specification 7-10.2(11) and Standard Details 340a and 340b.

When distribution system dead ends cannot be avoided, 8-inch and 12-inch standard main diameters should terminate with a fire hydrant. To the extent that additional water main is needed between the last hydrant on the dead end main and the end of the actual end of the main, a reduced diameter is preferred. Distribution blowoff valves are intended to support water main flushing involving these relatively short segments of smaller diameter water main. When incremental water main construction requires creation of a temporary dead end larger than 8 inch diameter a 4 inch blowoff or temporary hydrant should be provided.

Bypass Valves are non-modulating valves installed in assemblies around larger valves to ease valve opening, and around 3 inch and larger Domestic and Combination service meters to provide unmetered service during meter maintenance.

When a water main has been drained on one side of a large gate valve, the pressure on the valve disc becomes unbalanced making it very difficult to open the valve. A bypass assembly around the large gate valve allows water to fill the drained side of the gate valve. When the drained side is filled and the pressure equalizes on both sides of the gate valve, the valve opens more easily. Bypass assemblies also allow the operator to fill an empty pipe with much better control. Since large gate valves typically have bonnets that are quite tall, they do not fit under street paving. Therefore, these valves are installed laying on their sides giving rise to the term laydown valves and they typically have bypasses installed directly on the valve body.

Beginning in the 1990s, 16-inch and larger diameter line valves and isolation valves are typically butterfly valves (BFVs) due to their lower cost and smaller size. SPU learned that **BFVs must not be used to fill drained pipes**. The rubber seat on brand new BFVs can be destroyed after only one or two fillings of dewatered pipe.

SPU practice is to install bypass assemblies on all valves 16-inches and larger diameter.

A typical bypass assembly is included in the standard line valve chamber detail, see Figure 5-5. The bypass assembly size is usually 4 inch for most locations. 6 inch or 8 inch may be needed for large-diameter transmission main bypasses to reduce filling time to an acceptable level. On each bypass assembly, SPU practice is to install two bypass valves, attached directly to the main line by flanged connections, one on each side of the main line valve. Between these two valves, the plumbing includes a tee with a down-turned outlet with a plug in the outlet. The bypass assembly is supported from the floor at the bends and at the tee. With this arrangement, the bypass assembly functions can also be used to drain the piping on each side of the main valve.

Where the pipe volume to fill is relatively small and the time needed to fill is only an hour or two, the bypass can be constructed by installing 1-½" x 2", AWWA x MPT, brass-bodied ball corps on the top of the pipe, on each side of the BFV line valve, which saves considerable space. (See Figure 5-5, Keyed Note 4.) SPU crews can then plumb the

bypass from corp-to-corp with copper fittings and tubing to perform the filling function as needed.

2) Modulating (throttling) Valves

Modulating (throttling) Valves are valves that are suited for operating in a partially open position, and which have can adjust the percent open as often as needed. Modulating Valves typically have an automatic actuator governed by a measured parameter such as pressure, flow rate, or elevation. SCADA control or local / remote manual position selection is also used to control modulating valves. A modulating valve's percent open is adjusted as needed in response to changing system conditions measured either upstream or downstream or both to produce a desired outcome in form of water pressure, flow rate or water surface levels.

Remote control valves are modulating valves that have various applications within water system facilities. Principally, they are used to control water flow from a higher pressure water source to a lower pressure receiving pipe that in turn supplies a pressure zone. Remote control valves are able adjust their percent open between fully closed and fully open using an actuator whose position is set remotely via SCADA. Remote control valves are normally powered by an electric motor, though other actuator styles also exist depending on electric power availability, valve location, and control requirements. Many applications require the control valve to throttle for long periods. Owing to its suitability for throttling and low operating torque requirements, metal-seated ball valves are the preferred valve type for use as a modulating remote control valve.

Pressure regulating (PR, or PRg) valves are globe style bodied modulating valves that permit water flow in one direction only, acting between an upper service zone or pressure source to a lower pressure zone. It finely controls the rate of water flow through small changes in the valve's position called modulation. The valve's position is driven hydraulically by the difference in upstream and downstream water pressures acting upon opposite sides of a flexible diaphragm. The diaphragm is attached to a disc whose diaphragm-modulated height over the valve seat creates a continuously variable resistance to water flowing past the seat. Pressure regulating valves are designed for the severe application of passing high flow rates together with high pressure drops.

Globe valves can be configured to control many different applications by the use of control pilots that measure pressures upstream and downstream of the valve and adjust the pressures on the diaphragm to produce the desired regulating function. Pressure regulating valves continuously and automatically respond to pressure changes in the system. They open and close as needed to maintain the set pressure or function for which they are designed.

Due to SPU's investment in trained maintenance personnel, large stocked inventory of replacement parts and regular on-going maintenance schedule for all PRGs, SPU only installs PRGs manufactured by CLA-VAL.

PRGs can be further broken down into the following common regulating functions using specific configurations of globe valve pilots:

1. Pressure Regulating Valves that are designed to maintain a set pressure downstream of the valve regardless of upstream pressure are called *Pressure*

Reducing Valves (see a specific application below). Pressure Reducing Valves are sized to pass the maximum required flow rate while remaining at or below the manufacturer's recommended maximum flow rate. However, large Pressure Reducing Valves cannot control both downstream pressure while also passing low flow rates like those commonly associated with a diurnal demand curve. This condition causes PRg instability and surging within the upstream and downstream service zones and is to be avoided. Therefore, large Pressure Reducing Valves that meet the maximum demand while maintaining the downstream pressure set point are commonly paired with one or more smaller Pressure Reducing Valves that handle the low flow rates. These parallel valves have downstream set points that differ by 3 to 5 psi. The smallest parallel valve will be set to maintain the highest downstream pressure set point, which matches the service zone pressure. If the smallest valve cannot keep up with the service zone demand, the pressure loss through the valve increases and the pressure in the service zone begins to drop. When the service zone pressure drops to the set point of the next larger valve, it will begin to open and the system demand will be shared by both PRgs. This process of shared flow rate continues for as many legs as are in the PRg station that are needed to meet the service zone demand and pressure requirements.

2. Pressure Regulating Valves that are designed to maintain a set pressure in the upstream side of the valve while passing as much water as possible to a lower pressure zone are called *Pressure Sustaining Valves*.
3. Pressure Regulating Valves that maintain a set downstream pressure if possible, while simultaneously being prioritized to maintain a minimum upstream pressure is called a *Combination Pressure Reducing and Pressure Sustaining Valve*.
4. Pressure Regulating Valves that are designed to maintain a set down stream or upstream pressure while limiting the maximum flow rate through the valve are called *Rate of Flow Control Valves*. This function is very useful if the head difference is high between the upstream service zone and downstream service zone and the PRg size is known to be incapable of maintaining a set downstream pressure. If rate of control is not used in this condition, the PRg will quickly be destroyed by high water velocity through the valve while trying to meet the downstream demand.

Summarizing some key points above:

- Size the valve based on both maximum expected normal flow rate and the minimum expected flow rate. Then check to see that the intermittent maximum flow rate is not exceeded for the valve. A valve that experiences too low of a flow rate will chatter, causing rapidly fluctuating pulsations in the system. A valve with too high of a flow rate will wear prematurely and may cavitate. A valve with an intermittent maximum higher than recommended can experience valve failure.
- Use parallel PRg legs of differently sized valves that sequentially open for control across all expected flow rates and pressures.
- Check that valve is suitable for the maximum differential pressure expected.

- Check that the valve is not expected to cavitate under any operating conditions. If cavitation is expected, CLA-VAL has a 600 series PRg that reduces cavitation.

Pressure Relief Valve (PRV): SPU limits the formal application of the abbreviation PRV to pressure relief valves. Pressure Relief valves employ the same globe valve and hardware as used in a PRg, but with a different configuration of its control pilot piping. A PRV continuously and automatically responds to changes in inlet water pressure to release water that exceeds a set pressure. Wherever a service zone is supplied by a PRg, a PRV must also be provided to protect the lower service zone from excess pressure that could accompany a malfunction of the PRg. The issue here is that if the PRV malfunctions:

1. It can happen at any time.
2. The valve may fail wide open, which is analogous to a direct connection from the upper service zone (SZ) to the lower service zone through a minor headloss.
3. A large increase in pressure in the lower service zone results from a PRg failure, which is injurious to customer and public piping systems. This pressure increase is the difference between the upper service zone's pressure at the PRg and the lower service zone's pressure at that location and is labelled ΔP_{PRg} .

To size the PRV we need to know the flow rate required and what pressure differential to use, which leads to the calculation of the required PRV's C_v . A quick rough analysis may be obtained via the following few steps:

1. The calculation of the maximum increase of flow through a PRg during a failure begins with knowing (or assuming) the minimum flow rate for the PRg in gpm. This is because the failure can happen at any time, including low demand periods in the system's diurnal curve when the systems' pressures are typically highest; this is the worst-case failure scenario.
2. Obtain the maximum normal pressure differential between the two service zones, (ΔP_{PRg}). This can be quickly done by subtracting the lower service zone's maximum hydraulic grade in feet from the upper zone's hydraulic grade in feet and dividing by 2.31 ft/psi. For instance, a PRg between the 585 SZ and the 480SZ would be $(585' - 480') / (2.31' / \text{psi}) = 45.4 \text{ psi}$.
3. Obtain the PRg's C_v from the manufacturer's published literature.
4. Knowing C_v and ΔP_{PRg} , calculate an initial maximum flow through the PRg:

$$Q_{gpm} = C_v / \sqrt{1 / \Delta P_{PRg}}$$
5. Subtract the minimum flow rate in step 1. The result is the flow rate that the PRV has to remove from the lower service zone to protect the pressure there. Understand that when water at this flow rate is removed from the lower service zone, the water has to go somewhere. Part of PRV design includes providing a safe means for disposing of this flow rate.
6. Determine the pressure differential that the PRV will experience. Use the lower service zone's normal maximum pressure at the PRV site, which may be different from the PRg site though they should be as close as possible. The PRV will usually, though not always, discharge to atmospheric pressure so ΔP is typically just the PRV site pressure. Consider though that piping required to

route the discharged water to a safe location may produce back pressure at the PRV, which must be subtracted from the lower service's normal maximum pressure. This may require iterations of calculations.

7. With the flow rate (Q_{gpm}) and the pressure difference ΔP_{PRV} the minimum required C_v for the PRV is calculated: $C_v = Q_{gpm} * \sqrt{1/\Delta P_{PRV}}$
8. Select a PRV size where C_v is at least as high as the one calculated.

The steps above lead to a rough solution using assumed worst conditions and will result in the largest PRV capable of handling the flow rate. If the resulting required PRV C_v is near a smaller PRV's C_v , or if significant small diameter pipe with rough walls is present in the PRV source or discharge system, the analysis should be refined using hydraulic modelling.

Pressure Reducing Valves (also informally referred to as PRVs) are 2 inch and smaller modulating valves that are owned by customers to reduce high pressure in the water main to 80 psi (or lower) as required by the building code. Pressure reducing valves use adjustable spring compression in opposition to the force produced by domestic water pressure acting on a diaphragm to control globe valve position. As the customer uses water, the pressure in the domestic piping decreases to a point where the spring pushes the valve open to provide the demand at the set pressure.

Pressure Release Valves (also informally referred to as PRVs) are 2 inch and smaller modulating valves that are owned by customers and are similar in function to pressure relief valves discussed above, except on a much smaller scale. When the small spring in these valves is overcome by domestic pressure higher than allowed by the plumbing code, the valve will open and discharge water to the ground or drain on private property. Where SPU water main pressure exceeds 80 psi, customer-owned pressure reducing valves are necessary to protect interior plumbing from either failure of the customer's Pressure Reducing Valve or a condition caused by water expansion in the hot water tank not being able to escape the domestic plumbing, which causes increased pressure.

3) Check (non-return) Valves

Check (non-return) Valves are valves that are designed to permit water flow in one direction only. They open automatically when the pressure on the receiving side of the valve drops below the inlet side of the valve. They close when the downstream pressure rises to the inlet pressure.

Check valves have a variety of functions in the water system facilities. Within the transmission and distribution system, check valves have five common uses: Backflow Prevention Valves, Pump Discharge Check Valves, Purveyor Meter Check Valves, Source Selection Check Valves and Service Zone Boundary Check Valves.

Never mount a check valve in a vertical pipe. This is tempting in pump stations where space can be saved, but debris can build up behind the moving elements and prevent it from opening fully which in turn causes increased headloss and degraded system performance and in some cases a loss of check valve sealing capability altogether.

Check valves are mechanical equipment with automatically moving parts that need to be maintained. Therefore, check valves are always installed inside a chamber or building for ready access; they are never direct buried. They are always bracketed upstream and downstream with isolation valves to permit inspection. For this reason, always provide a means to dismantle the pipe run between the isolation valves.

Backflow prevention valves are check valves that separate the SPU potable water system from non-potable systems to prevent cross connection contamination.

Pump discharge check valves act quickly and automatically on pump discharges to prevent return flow through the pump in the event of a power loss. Non-slam characteristics are essential in check valve selection for this application. The check valve size is selected to match the pump discharge. It is always the next size larger where the pump discharge connection is a non-standard water main size. For instance, a 5 inch discharge would be increased to 6 inch and then a check valve would be next. It is best to sandwich the check valve between the pump and the pump control valve, if there is one. Both the pump control valve and the check valve should be located between isolation valves to permit inspection and maintenance of the pump, control valve and check valve in the same shutdown.

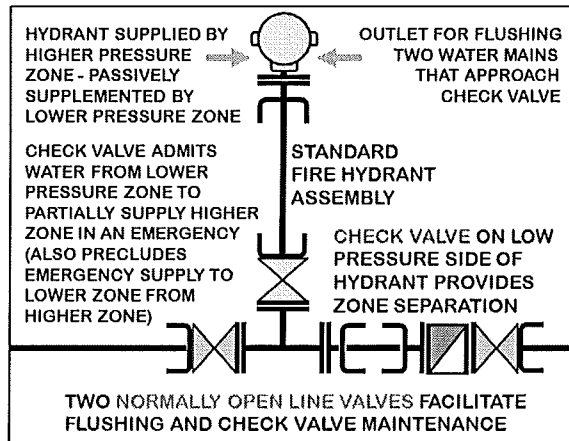
Purveyor meter check valves are placed inside a vault after SPU's metering equipment and before SPU's isolation valve closest to the service union, which is outside the vault. This ensures that all metered water belongs to the customer and cannot return to SPU's system if the pressure reverses for any reason. Placing the check valve before the isolation valve allows SPU to maintain the valve without requiring the purveyor to depressurize and drain his system.

Outlet check valves are used on the downstream side of branch valves attached to outlets on transmission mains and certain feeder mains. In this application, check valves ensure that distribution pressure zones are supplied first from distribution storage. If demand in a distribution service zone pulls the pressure below that of an adjacent supply main, the check valve on the branch connection to the larger main will open. Flow from the transmission or feeder main will help the distribution pressure zone meet demand, and help to keep pressure in the zone from falling further. In addition to reducing the need to construct additional distribution supply, check valves on large main outlets also simplify the process of shutting down large feeder or transmission mains by automatically eliminating reverse flow from the distribution grid mains into the supply main.

Service zone boundary check valves are sometimes installed as the separation device between two adjoining service zones instead of a District Valve. If fire demand or other large water demand inside a higher-service zone requires immediate supply augmentation from a neighboring lower-service zone, a service zone boundary check valve can automatically open to supply the temporary increased demand. The resulting flow into the higher service zone may be at an undesirable pressure for normal domestic service, but the inflow can significantly increase the flow available to a fire pump. The service zone boundary check valves can only work where the two adjacent service zones are relatively close in hydraulic grade and usually makes sense at locations that are

farthest away from the service zone's source and are fed by small mains or mains with high friction characteristics. Modeling the performance of the two adjacent systems together is the best way to determine if a service zone boundary check valve is needed.

Figure 5-7
Pressure Zone Boundary Check Valve Co-Located with Fire Hydrant



When immediate and automatic supplementation of the higher pressure zone is not crucial, check valves between zones should be avoided. By its nature, a zone boundary check valve prevents emergency water transfer from the higher-pressure zone into a lower-pressure zone.

Note that a district valve (DV) facilitates emergency water transfer between zones in either direction. Though a DV is the preferred pressure zone separator, a check valve may have a role in correcting low fire flow conditions at specific hydrants, or when an instantaneous back-up supply is desired for zone normally supplied by a single source vulnerable to sudden loss.

4) Air Valves

Air valves are devices that permit or restrict the movement of air, under a controlled manner, into or out of distribution mains, feeder mains, supply mains and transmission mains as well as some other appurtenances such as pump casings and pump discharge pipes. The amount and type of air control varies according to the design function required. Air valves function automatically in virtually every application, and they do so without the need for any external power source. However, they do require regular maintenance and must be installed inside a chamber; they are never direct buried.

By their nature, air valves are a potential pathway to cross connection contamination. They are designed to physically separate the potable water environment inside the pipe, while admitting air from, or releasing air to, the non-potable environment. Installing them improperly can enable non-potable water or other contaminants into the potable water system.

To prevent cross connections Washington State DOH regulations do not allow air valve vent piping to terminate inside a chamber. This practice from many years ago has been

permanently discontinued. For this reason, air valve vent pipes must be plumbed directly from the valve outlet to above the ground surface. The air valve vent pipe must terminate at 18 inches or more above ground surface where no flooding is expected and where flooding can occur the termination must be at least two pipe diameters above the 25-year flood plain, or greater depending on site conditions.

Air valves inside pump stations or large valve stations may terminate inside a building provided the building is ventilated, there is a primary sump pump with a back-up sump pump, and there are alarms to OCC with power back-up for conditions such as power loss, sump pump failure, and two sump high water levels. This level of equipment and instrumentation normally only occurs inside major facilities containing pumps, motor control equipment, electronics and other equipment that cannot endure the presence of standing water or high condensing humidity.

Air valve functions and design is covered in depth in AWWA Manual M51.

SPU makes use of fire hydrants and frequent water service connections to supply and exhaust air during draining and filling procedures of shutdowns involving most distribution water mains.

Air valves are required on transmission mains, feeder mains and distribution mains lacking hydrants and/or water services at profile high points.

Air and vacuum valves (AVV, large orifice air valve or air/vac valves) represent the minimum requirement for air and vacuum management in mains requiring autonomous large air supply and vacuum relief provisions. AVVs are placed at highpoints along the water main's profile. They permit large-volume admission of air during the draining of a pipe, thus preventing harmful negative pressure. During the refill of a pipe, an AVV remains open to allow large-volume of air to escape that is being displaced by incoming water. During filling, the pipeline experiences only minor pressurization due to restrictions while air is exiting AVVs. Hence it is very important to refill large pipe at a slow enough rate that when the final air pocket is expelled that the hydraulic transient (unsteady flow, also called water hammer) is not excessive.

When the water level reaches the crown of the pipe at the crest of the pipe profile, water will enter the AVV body, and a float inside the valve will seal off a large orifice at the AVV's discharge opening. When the float seals the large air valve orifice, the valve cannot re-open while there is water in the valve or while the pressure on the inside of the pipe is higher than atmospheric pressure. This is another reason to refill pipelines slowly. Some AVV's have a tendency to blow closed during filling and once this happens, there is no way to reopen them again unless the refilling is halted and the minor interior refilling pressure is taken off the pipe. In short, Air and Vacuum Valves operate fully open or fully closed. Once closed, an AVV will remain closed, even if air from the shutdown operation begins to accumulate at the highpoint. Furthermore, Air and Vacuum Valves cannot discharge air that may accumulate after being entrained or dissolved into water passing through the pipe after it has closed.

Air inflow at AVVs under some conditions has such a high velocity that a condition termed *choked flow* occurs. This condition happens when the pipeline internal pressure approaches 0 psia and is an unusual condition. In this condition, the Mach Number approaches 1 and the atmospheric pressure can no longer increase the airflow rate

since the air experiences both restrictive headlosses and expansion as it passes through the valve's air passages. When choked flow occurs, the air velocity has reached the sonic velocity through the valve and it sounds very loud like a jet engine roar, which is unacceptable in neighborhoods. To limit this, the location of the highest velocity and intensity of sound is inside a vault where the air valve is located. The vent pipe is increased after the discharge pipe near the air valve and the highest velocity noise will not occur in the neighborhood environment.

Also, to help minimize the possibility of choked flow happening, AVVs are sized to admit air at the maximum expected draining flow rate while maintaining a 5 psig differential between atmospheric pressure and pipeline internal pressure. Consult the air valve manufacturer's literature to determine the correct size for the application under design. This 5 psig differential is also important because gaskets of ductile iron pipe joints can have their gaskets sucked into the pipe during high vacuum conditions, which ruins their ability to contain water under pressure.

Air release valves (ARV or small orifice air valve) are air valves that open to expel small accumulations of air when the main is under full pressure, but they are not designed to exchange the large volume of air that accompanies water pipelines draining and refilling that AVVs can pass. Air release valves supplement Air and Vacuum Valves along lengthy horizontal runs between highpoints where long runs of pipe accumulate entrained or dissolved air, which effervesces as the pressure decreases at local high points. However, there are applications where only an ARV will be by itself at a local minor high point. So the design of the air valve orifice size becomes important.

AVVs have floats that rise when the air valve body is full of water. When the float rises, stainless steel links and/or levers place a small pad of rubber across a small orifice at the valve's discharge. When air enters the valve body, in an empty pipe, the pipe fill rate may experience a nearly unrestricted resistance at first, but the pipe will begin to pressurize slowly because the fill rate is nearly always higher than the ARV's designed discharge rate. This is somewhat different from a large orifice valve.

At some point during filling, the water levels on both sides of the local high point will connect and the remaining cavity of air will be released until the pipe is full, and water will enter the ARV body at a high rate of speed. This is because the viscosity of air is so much lower than that of water (about $1/15^{\text{th}}$). Air will leave the valve very abruptly and water replacing the air will enter the valve body under a considerably high velocity.

Water entering the valve will raise the float and when the float shuts the air orifice, the water comes to an abrupt halt and hydraulic transients will form in the pipeline. The high pressure associated with water hammer is partially due to the change of flow velocity in the pipe, not in the valve body. If the air cavity in the pipe is exhausted slowly, the transient pressure will be low.

In rough terms, a one foot-per-second (fps) change of relative velocity of water is sufficient to cause a 40-50 psi pressure rise in most steel or ductile iron pipes. The air valve's orifice is designed to allow the internal water pressure to force the air out in a controlled squeezing effect. An oversized orifice will allow the air to leave more quickly under the same pressure conditions as a smaller orifice. As a result, the manufacturer's literature must be consulted for designing air release valves.

The design literature will rate the ARV's air outflow rate in standard cubic feet per minute (SCFM) at specific pressure differentials. The ARV's discharge rate must be selected to force the water filling the pipe to do so under a slow enough rate that the water hammer that will occur is acceptably low. To do this, first realize that in the final stage of filling, the water will be approaching the high point from possibly both directions and it is the relative speed of bubble collapse that matters in pressure transients.

Select the design relative velocity (two water columns joining) of filling rate in feet-per-second and calculate the pipeline cross-sectional area in square feet. The compressed air flow rate out of the valve can be calculated as Velocity X Cross Sectional Area.

Convert compressed air flow rate in cubic feet per minute (CFM) at the assumed pipeline temperature to SCFM under standard conditions by the relationship:

$$\text{SCFM} = \text{CFM} * (\text{internal pressure, psia}/14.7\text{psia}) * (528^{\circ}\text{R}/\text{Pipeline Temperature } ^{\circ}\text{R})$$

$$\text{Where } ^{\circ}\text{R} = (^{\circ}\text{F} - 32) + 491.67$$

And where most pipeline internal temperatures are near 50°F ±5°F

Then using the manufacturer's literature, select the orifice size that matches the pipeline's pressure and SCFM requirement.

Combination air valves (CAV) are air valves that function as AVVs during pipeline filling and they function as ARVs once the large orifice has closed and the pipeline is pressurized. Choked flow provisions of AVVs must be designed. The ARV side of the air valve adds the ability to continue to expel air that may accumulate at the highpoint after the AVV has closed. Combination Air Valves are also appropriate for mains that connect with laterals that do not have complete air release provisions and they are advised for mains with long subtle increasing profiles where air can accumulate along the crown of the pipe.

Vacuum valves (VV) are air valves that are used where the primary concern is automatically admitting large amounts of air into the pipe to prevent damaging vacuum conditions from developing during negative pressure transient events. Because of the purpose of VVs, the highest of air inflow rates is expected. Choked flow provisions of AVVs is essential. Some VVs employ an automatic check disc to release the admitted air in a slow controlled manner when positive pressure returns in order to prevent high pressure spikes upon regaining the full pipe condition. Other VV designs trap the air once it enters and will not release it. Where this occurs, a separate ARV will often be placed at a nearby location to release the trapped air. Vacuum Valves are designed in conjunction with a transient analysis and are designed for the specific pipeline's transient characteristics.

Vent pipes must be installed so that they have a constant upward slope toward the vent pipe opening.

In order to prevent cross connections as mentioned earlier, the Washington State DOH requires the air vent piping on the discharge (atmospheric pressure) side of every air valve to discharge above ground and above the 25-year flood plain. This is accomplished through an aboveground standpipe assembly comprised of a vent pipe inside a

protective casing. Where possible, SPU requires the vent pipe to be at least one nominal pipe size larger than the size of the air discharge port on the air valve. This reduces the potential of high velocities and resulting noise at the point of contact with the neighborhood environment and it reduces airflow friction losses, which hinders the air valve's performance.

Where the standpipe assembly is exposed to traffic collisions, the assembly must include a base breakaway feature that will protect the air valve from damaging forces and structural deformations that may be imposed on the standpipe assembly during a collision or other mishap.

The above ground portion of the standpipe assembly must also be designed to prohibit vandalism and the ability to introduce contaminants into the air valve's vent pipe. One method that has worked well is to place the vent pipe inlet inside a much larger diameter casing with heavy screens welded to the inside of the casing at openings. With the top of the screened openings located 12 inches to 18 inches below the top of the casing, the air inlet would be located above the heavy stainless steel screen by several inches and be supported laterally inside the casing in a manner that puts the vent pipe's entrance out of reach of tampering. The top of the casing is closed with a heavy plate welded to the casing pipe and the base is bolted or otherwise secured to a concrete slab or vault top in a manner that allows maintenance to be performed while prohibiting removal by vandals. Be sure that there is more open area provided in the heavy screen than the vent pipe area. The air will need to flow through the screen and negotiate the annular space between the outside of the vent pipe and the inside of the casing. This will cause air pressure drop and must be kept as low as possible.

The types of valves used in the SPU water system are shown in Table 5-6. For more information on valves, see Standard Specification 9-30.3.

Table 5-6
Valve Uses within SPU Water System

Use	Type	Typical Sizes	Comments
Line Valve	Gate, AWWA C509 resilient wedge	4" – 12"	• Typically used for smaller line valves
	Gate, AWWA C500 double disc	4" – 12"	• No longer commonly used • has a very long lead time to purchase • Only ductile iron bodies allowed • SPU buys and stocks a supply on a yearly basis due to long lead time • Many larger sizes are in the system
	Gate, AWWA C515 resilient wedge		• Has thinner body • Not used for Line Valves
	Butterfly, AWWA C504	4"-12"	• Can be used on shallow mains • More head loss than other valves • Debris in main can hinder operation • Cannot be pigged
	Butterfly, AWWA C504	16"- 84"	• Typically used for line valves • More head loss than other valves

Use	Type	Typical Sizes	Comments
	Ball, AWWA C507	4"-48"	• Excellent closure characteristics • Very Costly • Low head loss • Rarely used as a Line Valve
District Valve	Gate, AWWA C500 double disc	4"-12"	• Always placed in a chamber • generally closed • locked out
Backflow Prevention	Check Valve, AWWA C508	4"-16"	• Only allows flow in one direction • Several styles available • Check the slam characteristics
Air Release	Air Release Valve (ARV), AWWA C514	¾" - 2"	• Air release through a small orifice • Large orifice air valve
Air and Vacuum	Air Vacuum Valve (AVV), AWWA C514	2" - 16"	• Allows air into or out of pipe during draining or filling. • Performs function of both admitting into and exhausting air out of pipe
Combination Air Valve	Combo Air Valve (CAV), AWWA C514	4" - 16"	
Pressure Regulating Valve (PR valve)	Control Valve, AWWA C530	2"-16"	• Maintains a constant downstream pressure
Pressure Relief Valve (PRV)		2" - 8"	• Allows system pressure to increase to a maximum value before opening to release water to prevent further increase of the system pressure
Double Valve Throttling System	Gate, AWWA C500 double disc	4"-8"	• Typically the throw away valve in double valve setup
	Gate, AWWA C515 resilient wedge	4"-8"	• This valve is a thin-walled Gate. If used, these are typically the throw away valve in double valve setup
	AWWA C509 Gate or AWWA C504 high pressure butterfly	4"-8"	• Typically the On/Off valve in double valve setup
Long-term Throttling	Ball, AWWA C507	2"-36"	• Long-term high head throttling valve
	Plug, AWWA C517	4"-8"	• Long-term high head throttling valve, now they are typically only put on high head blowoffs

B. Valve Placement Strategy within the Water Distribution System

The primary role of line valves in the water distribution system is to execute various alternative water supply paths available in the water system. Gridding and looping features are examples of water supply redundancy designed into a water distribution system to improve water service reliability during water main failure events and maintenance shutdowns. Line valve operation is how a water utility actually achieves a return on past redundancy investments when a main segment must be shut down. Without thoughtful line valve placement, the best-intentioned dual or back-up supply schemes can be rendered useless by a single point failure of a water main. When planning valve placement, it is helpful to consider how far water service can be extended under a given main failure scenario, as opposed to minimizing how many pipe segments would need to be shut down to control the failure.

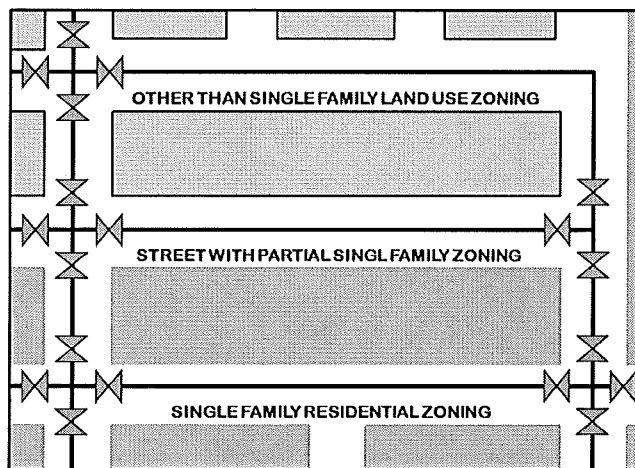
1) Isolation at all nodes in the grid and networks

Place line valves at junctions connecting segments of the distribution grid and at junctions connecting segments of the feeder and transmission backbones, such that each of the converging main segments can be independently isolated.

2) Valve Placement in the Distribution Grid

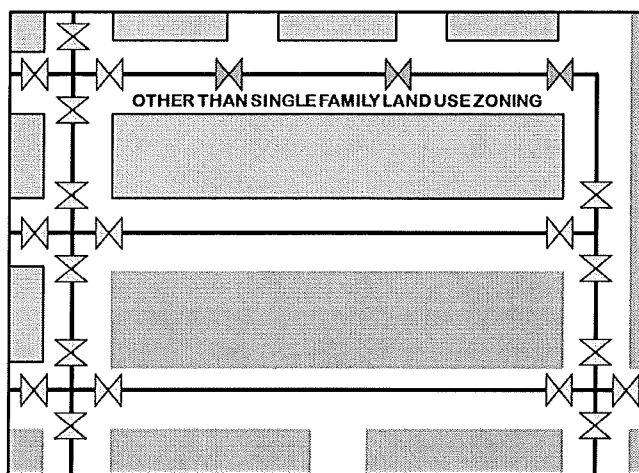
Provide valves on all mains at grid junctions, for all zoning designations, as shown in Figure 5-8.

Figure 5-8
Example of Valves on All Mains at Grid Junctions



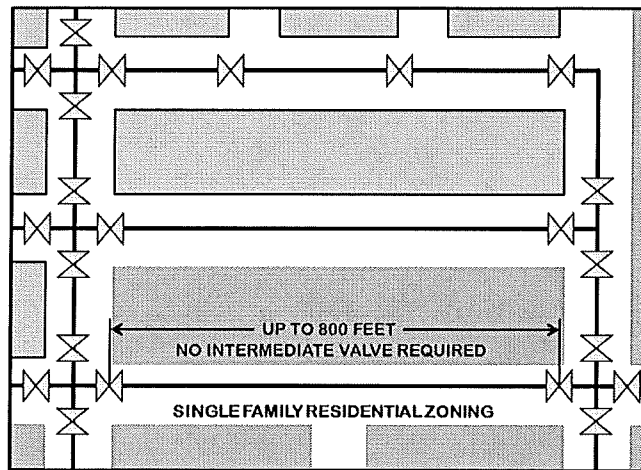
Additional intermediate line valves are required between grid connections, such that any single shutdown segment will be no more than one block or 500 feet in length, whichever is less (except in SFR Zones). See Figure 5-9.

Figure 5-9
Example of Intermediate Valves at Cross Streets



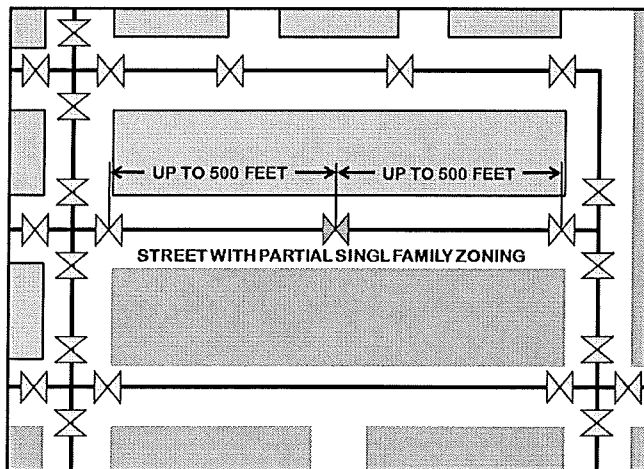
Single-family residential exception: In single-family residential zones, line valves are required on all water mains approaching a grid junction. However, intermediate line valves between junctions are required only as needed to create water main shutdown segments not to exceed 800 feet in length. See Figure 5-10.

Figure 5-10
Example of Intermediate Valves in SFR Zones



When a street is abutted by properties zoned as single-family residential and properties zoned for use other than single-family residential, use general valve spacing guidelines of 1 block or up to 500 feet between valves. See Figure 5-11.

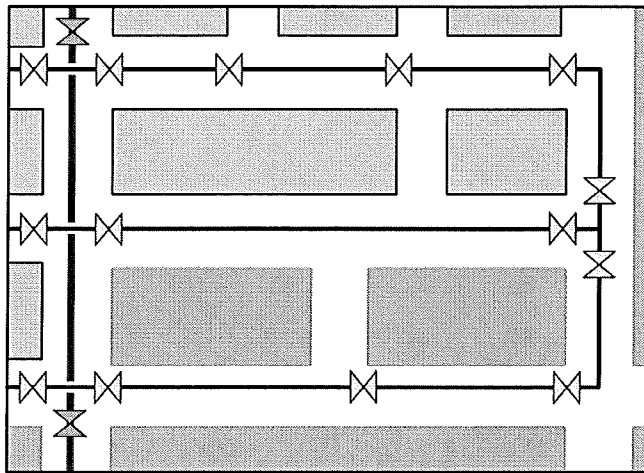
Figure 5-11
Example of Intermediate Valve Spacing – Partial SFR Zoning



3) Valve Placement along Feeder Mains in the Distribution System

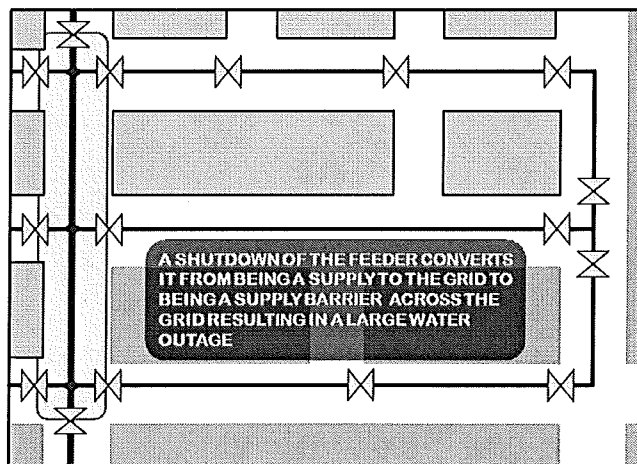
On distribution mains and feeder mains larger than 12 inches in diameter, valves must be located where these mains intersect with other mains larger than 12 inches, such that each of the converging large diameter main segments can be independently isolated. Additional intermediate valves are required between large diameter pipe junctions, such that any shutdown segment of a main larger than 12 inches in diameter will be no more than 1,320 feet (1/4 mile) in length. See Figure 5-12.

Figure 5-12
Example of 1/4 Mile Valve Spacing for Large Diameter Mains



However, if a large diameter main is to be integrated into the water distribution grid, the quarter-mile valve spacing target may be very inappropriate because of its impact on distribution grid shutdown length and outage scope. See Figure 5-13.

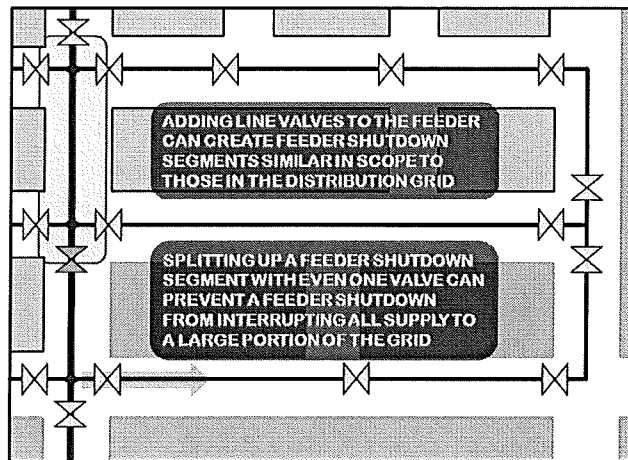
Figure 5-13
Example of 1/4 Mile Valve Spacing Not Appropriate with Grid-Integrated Feeder



When a larger diameter main interacts with the distribution grid, attention must be given to how potential shutdowns of the large main will affect service to distribution mains, fire hydrants, and water services. Feeder-grid interaction must not defeat the redundancy features incorporated into the distribution grid, or increase the shutdown/outage scope experienced by customers served by the grid or served directly off a larger diameter distribution main.

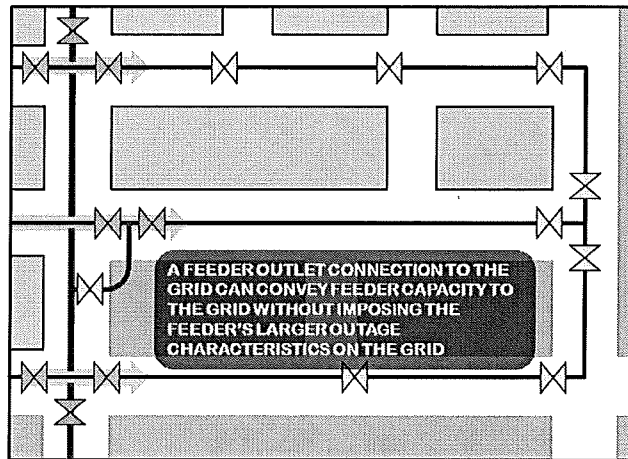
To protect the distribution grid from the effects of less frequent valve placement along large-diameter mains, the simplest modification is to add valves to the larger main to create shutdown segments no larger than what would be allowed for a distribution grid main. Because of the expense and street space required for large (>12") line valves, providing a line valve on each large diameter main approaching a feeder/grid junction may not be desirable. See Figure 5-14.

Figure 5-14
Example of Line Valves Added to Feeder Main



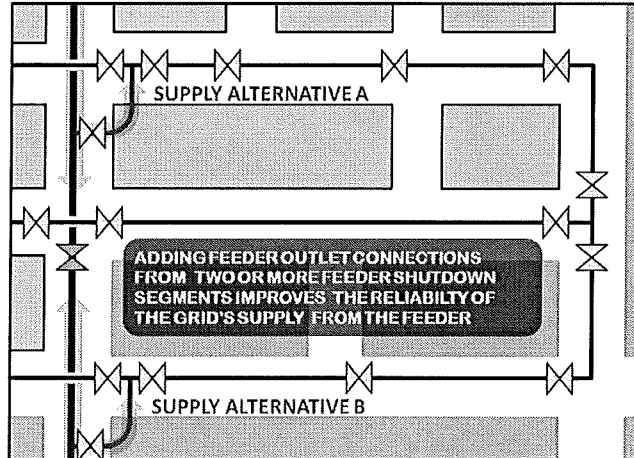
The shutdown/outage implications caused by infrequent placement of costly large-diameter line valves can also be addressed by not fully integrating the large main into the surrounding distribution grid. See Figure 5-15.

Figure 5-15
Main Separation between Feeder and Grid



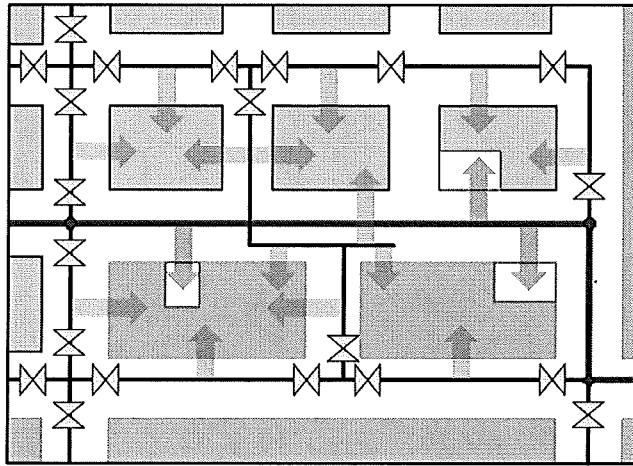
Multiple connections to the grid from different shutdown segments along the feeder can provide the grid with a redundant supply from the feeder that will tolerate a failure and shutdown of the feeder. See Figure 5-16.

Figure 5-16
Example of Improved Reliability from Adding Connections



When a large diameter main is fully integrated into the surrounding distribution grid, its higher shutdown/outage implications caused by infrequent valve placement can also be mitigated by avoiding direct customer and hydrant connections to the large main. See Figure 5-17.

Figure 5-17
Local Mains and Water Service Headers to Mitigate Feeder Main Shutdown Impacts



While reducing the number of customers and hydrants supplied by a large-diameter main will reduce the total impact of a shutdown involving the large main, the customers who are affected will experience the more lengthy service outage associated with taking a large main out of service. If the shutdown is due to a main failure, repair times associated with a large-diameter main will impose an even greater outage burden on customers directly connected to the large main.

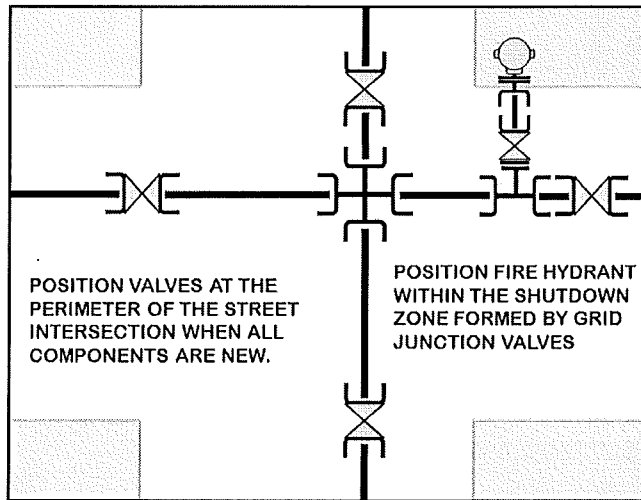
4) Valve Positioning Tactics at Specific Connection Points

The SPU distribution system primarily consists of gray cast iron pipe. Pipe segments and fittings utilize leaded connections, compressed rubber gaskets connections, and pressure-assisted rubber gasket connections. While existing cast iron pipe will continue to provide a long service life, lead joints are subject to hydraulic displacement and leakage, and cast iron pipe material is subject to fracturing and to pitting and leakage caused by corrosion. When specifying valve positioning at junctions in the distribution grid, keep these vulnerabilities in mind. Avoid valve arrangement that will leave a new supply redundancy feature open to defeat from a single failure involving existing vulnerable pipe.

All-new construction: When a grid junction will consist of all-new construction utilizing standard materials, valves should be positioned at the perimeter of intersections involving arterial streets. When the grid junction is to be located at a street intersection that will also include a fire hydrant, the fire hydrant should be contained within the shutdown zone formed by the perimeter valves. This arrangement allows the fire hydrant to be used for valve seating, flushing, draining, or air/vacuum management involving any of water main segments approaching the junction. The fire hydrant will remain in service under nearly all shutdown scenarios. Future water main repairs within the intersection can be scheduled for low-traffic hours, since pipe in the intersection can be fully isolated without affecting customers. Keeping line valves out of an arterial intersection makes safe valve operation easier, since the operator has to contend with traffic flow from only one direction at a time. When a grid junction is to be located in a

residential street intersection, incorporating valves into a tee or cross is acceptable if a fire hydrant is not planned for that intersection. See Figure 5-18.

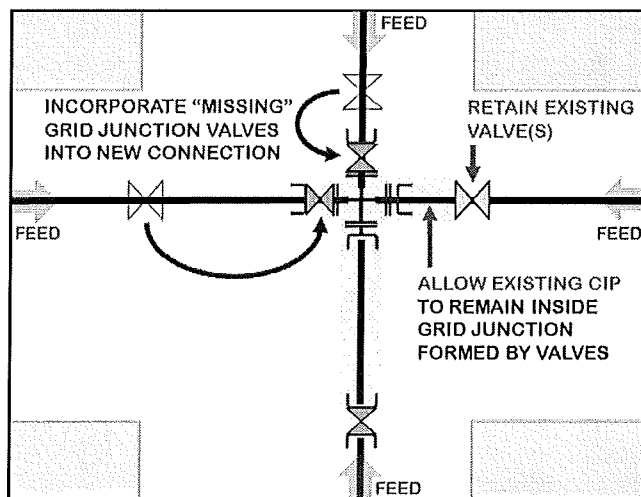
Figure 5-18
Default Positioning of Grid Junction Line Valves for All-New Construction



New Construction Connecting with Existing Cast Iron Distribution Mains

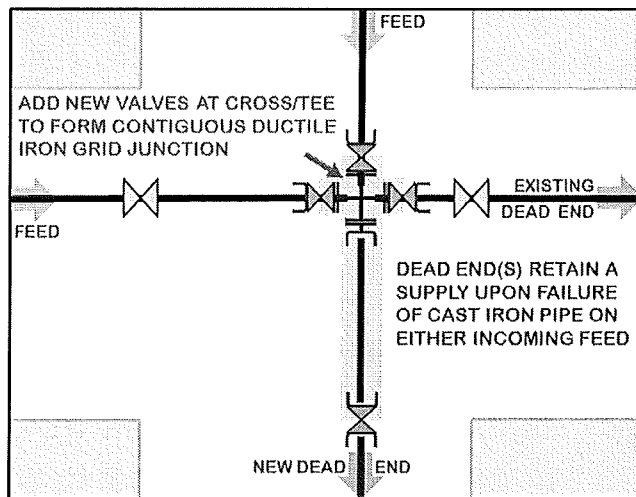
Looped system: When the new water main segment will form a supply loop (will receive water from two directions), then any grid junction created by the new water main can utilize the standard intersection valve positioning practices outlined under all-new construction. The new looped main can employ existing valves and existing cast iron pipe located in the intersection of the new junction. See Figure 5-19.

Figure 5-19
Existing Grid Junction Modification when Connecting New Looped Grid Main



Single-feed system: When the new water main segment will form a dead end, or will provide the only standard-diameter supply to an otherwise dead end area, the grid junction need to be arranged to ensure that the dead end leg extending out from the grid junction will receive supply from at least to two sources of supply entering the junction. Pipe and fittings within the valve junction formed by the junction valves must consist of standard materials. Existing cast iron and lead joint elements must be eliminated. See Figure 5-20 for an example of grid junction reconstruction using DI to ensure dual supply to dead ends.

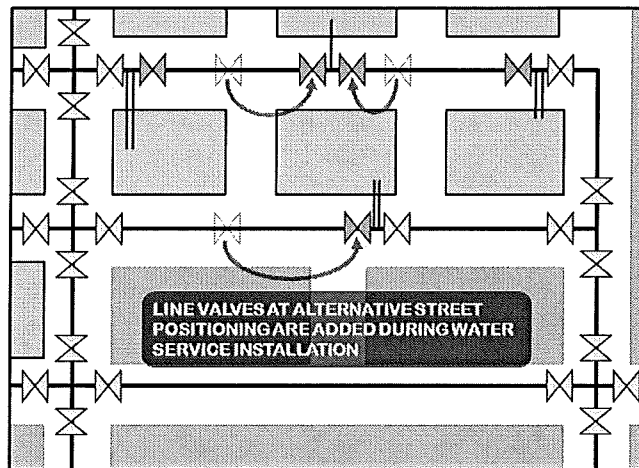
Figure 5-20
Reconstruction Grid Junction with Ductile Iron



Positioning of line valves not located at street intersections: The emphasis of line valve placement strategy is on using the grid and grid junction valves to keep water delivery options as plentiful as practical. Achieving the goal of insulating as many customers as possible from outages occasioned by maintenance and repair work is generally furthered by placing valves at grid junctions, which are typically located in street intersections. However, in areas with extremely intensive development, a single customer's building may take up an entire city block. The metered water service supplying a large footprint structure will typically be connected to a distribution main offering a one-block or 500-foot shutdown segment. Such relatively tight line valve spacing helps reduce the risk of service interruption caused by water main maintenance and repair. However, as outlined in the valve positioning tactics described above, connection of a new, dead end water main would include the creation of a grid junction capable of feeding the new dead end from either of two sources of supply. In the case of a high-rise residential tower or other large structure, a new water service connection functionally represents a new dead end main. When designing water mains or new water services that support large-occupancy structures, consider positioning line valves on the water main, at each side of the new water service tees that supply the building. Such line valve positioning becomes crucial to service reliability when the water services will connect with an existing cast iron water main that will require continuing maintenance and repair. Creating a gated ductile iron tee assembly for a new water

service connection becomes crucial to SPU system operators when the benefiting structure is continuously in operation, as in the case of a hotel. See Figure 5-21 for an example of line valves positioned at service connection points to create two independent feeds.

Figure 5-21
Line Valve Positioning to Create Multiple Independent Feeds



C. Clearances

Clearances around a valve are very important to operations and maintenance of the valve. When placing a valve in a chamber, the design engineer should ensure that maintenance staff can access all valve parts for maintenance and enough space for wrenches and other tools. Typically, a minimum of 1-foot space is needed around all valves. SPU prefers a 3-foot space if possible, but 18 inches minimum may be the best trade-off between chamber size and maintenance access.

D. Valve Restraint Systems

All valves in chambers and those installed on a restrained joint pipe should be fully restrained. There are several options for restraining valves, including flanges and a mechanical joint with a wedge restraint gland. The system chosen should be consistent with other SPU designs and consistent across the project.

E. Valve Replacement

The design engineer should pay close attention to removal of the valve. Valves 16-inch and larger should have an access hatch directly over the valve, adequately sized to remove the valve. Large heavy frames and covers are to be avoided if possible, though in traffic areas they may be unavoidable. A last-resort method of access is removal of the valve chamber top, which has significant traffic, paving, and cost impacts.

Another consideration for valve removal is a dismantling joint. When flanged valves are installed, the mating flange fit is extremely tight. If the valve needs to be replaced, unbolting it will not provide sufficient space to slide the valve out. A dismantling joint

has a special sleeve that can be retracted an inch or two. This allows enough extra space to remove the valve. The dismantling joint also provides some adjustment if a different brand or style of valve is installed in the future. SPU standard practice is to install a dismantling joint on valves 16-inch and larger in diameter. *Note that dismantling joints can transfer thrust in tension, but not in compression.*

5.6.4.2 Access Ports

SPU installs access ports typically on large-diameter ($\geq 16''$) pipelines.

Access ports provide access during construction and to Operations staff. Typical access port sizes are 24 inches in diameter but smaller ones such as for access during cement lining of welded joints are also possible. Typical spacing for large transmission mains is 1,200 feet except in low areas subject to high groundwater tables. Because access ports typically only extend 1 to 2 feet above the pipeline surface, they can be buried or encased in a maintenance hole that extends to the surface. If the access port is fully buried, it should be well documented on the record drawing (as-built) so future Operations staff can find it. If possible, a waterline marker should be installed over the access port.

SPU typically installs all access ports vertically. In certain cases, a side-mounted access port may be necessary given space restrictions. A side-mounted access port layout is shown in the *Supplementary Design Details* chapter of AWWA M-11.

5.6.4.3 Air Gap Structures

Air gaps, also known as goosenecks, are required to prevent cross connections between the domestic water supply and any other liquid. The ultimate function of this air gap is similar to that of a check valve. Typically, air gap structures are located on facilities (e.g. tanks) or equipment (e.g. blowoffs or pressure relief valves) connected to the system. The gooseneck discharge end must be a minimum of two pipe diameters above ground with a minimum opening height of 12 inches above ground or two pipe diameters above the 25-year flood plain or above a receiving water surface whichever is higher. The pipe diameter to use in calculating the discharge height is based on the smallest pipe in the discharge system. Enlarging an air gap discharge pipe to reduce discharge velocity does not mean the gap distance must be increased. Air gaps are usually found near the end of the discharge line on pipeline and tank blowoffs.

5.6.4.4 Flow Meters

Flow meter selection is covered in more detail in *DSG Chapter 10, Instrumentation & Control*. When selecting a flow meter, make sure to follow the upstream and downstream clearances requested by the manufacturer. In general, there should be smooth straight pipe (i.e. no appurtenances, bends, fittings, or similar) for the equivalent length of 10 pipe diameters upstream of the meter and the equivalent length of 5 pipe diameters downstream. However, some flow meter technologies have overcome the straight pipe-run requirement. Be sure to understand the manufacturer's published literature on this issue.

5.6.4.5 Fire Hydrants

Fire hydrant installations must be in accordance with the current version of the City of Seattle Standard Specifications Chapter 7-14 and Standard Plans 310a, 310b, 311a, 311b, 312, 313, and 314.

Hydrants must be located in areas that are accessible and approved by the Seattle Fire Department, or other fire department with jurisdiction at the hydrant location.

SPU places fire hydrants at specific intervals along standard water mains in the distribution grid. This level of service is intended to provide very general hydrant coverage for all properties abutting a street that is occupied by an SPU standard distribution water main. SPU does not provide hydrant coverage where there is not a need for an SPU water main. SPU does not add extra hydrants beyond those provided by standard spacing practices. SPU hydrant spacing patterns are intended to benefit the community, and to allow any one hydrant to be placed out of service without creating an unreasonable risk. Consequently, SPU hydrant spacing provides for hydrant frequency that is more generous than required by the Fire Code. Water main design must include hydrants at standard spacing, even though the specific property constructing an SPU water main may not be obligated by the fire marshal or building authority to install a hydrant.

To the extent that an SPU standard water main exists and has sufficient capacity, SPU will support property-specific fire suppression needs by installing a fire service or a combination fire and domestic service when purchased by the property owner. The sufficiency of the water main is determined when the owner applies for a water availability certificate. See *DSG Chapter 18, Development Services*, section 18.6.2.

A. Hydrant Spacing

Hydrants are to be placed at intersections. Additional hydrants are to be provided as outlined below:

1) Single-Family Residential Areas

- Where intersections are based on a 330-foot street grid pattern, no intermediate hydrant is used between intersections.
- Where intersections are based on a 440-foot street grid pattern, no intermediate hydrant is used between intersections.
- Where intersections are based on a 520-foot street grid pattern, an intermediate hydrant is required when abutting lot depth is greater than 100 feet, and is otherwise allowed.
- Where intersections are based on a 660-foot street grid pattern, an intermediate hydrant is required
- Where intersection hydrants are farther than 660 feet apart, provide one or more evenly spaced intermediate hydrants to achieve spacing targeted at a minimum separation of 300 feet, not to exceed 400 feet.

2) Commercial and Industrial Areas

- Where intersections are based on a 330-foot street grid pattern, no intermediate hydrant is used between intersections. A second SPU hydrant may be installed at an intersection if requested.
- Where intersections are based on a 440-foot street grid pattern, a second SPU hydrant at an intersection or midblock hydrant is required.
- Where intersections are based on a 520-foot street grid pattern, an intermediate hydrant is required.

- Where intersections are based on a 660-foot street grid pattern, an intermediate hydrant is required.
- Where intersection hydrants are farther than 660 feet apart, provide one or more evenly spaced intermediate hydrants to achieve spacing targeted at 300 feet or less.

5.6.5 Rehabilitation of Existing Mains

SPU rehabilitates existing water distribution main either through slip-lining the pipe or re-lining the large diameter pipe. Additionally, cathodic protection can be used to prevent further corrosion of the buried exterior. For detailed information, see DSG Chapter 6, Cathodic Protection.

5.6.5.1 Slip-lining

In slip-lining, a pipe of smaller diameter is installed within the original larger pipe. Usually slip-lining is performed on distribution or feeder main pipes 30-inches or larger in diameter. The existing pipe becomes the casing for the new pipe. It is often a cost-effective no-dig alternative to traditional open-cut installation of pipe. Typically, slip-lining is used as a structural repair. However, it cannot be used if there is substantial damage (crushed or misaligned joints) to the pipe. The annular space between the two pipes is sometimes filled with grout. The design engineer should carefully consider the hydraulic implications of reducing the pipeline diameter.

5.6.5.2 Relining

If video inspection of the pipeline interior shows significant deterioration of the lining, relining of the pipe may be possible. Pipes are relined by thoroughly cleaning the existing pipe interior then using a machine to spray-coat new cement mortar lining inside the pipe. The method used depends on pipe size. The relining can be designed to strengthen the pipe through use of a structural mesh embedded in the spray-coated cement mortar lining.

5.6.5.3 Cathodic Protection

Cathodic protection is one method SPU uses to extend the life of existing water pipelines. For more detail on cathodic protection for distribution and feeder mains, see DSG section 5.6.8 and DSG Chapter 6, Cathodic Protection.

5.6.6 Emergency Pump Connections

In some emergencies, a connection between two nearby pipelines may be needed. If the pipelines operate in different pressure zones, then a pump may be needed between the two lines. If possible, use an existing interconnection. If no inter-connecting pipe structure is available, SPU recommends using a nearby blowoff location and installing a pump between the two pipelines.

5.6.7 SCADA

See DSG Chapter 10, Instrumentation & Control, for SCADA system design. The design engineer should consider whether any monitoring or controls are needed and if the controls should be linked to the system wide SCADA system.

5.6.8 Corrosion Control

Corrosion control of SPU pipelines comes from both active and passive protection systems. Bare metal steel or ductile iron pipe will rust when exposed to corrosive soils or water if no protection system is installed. The rate of corrosion depends on the corrosivity of the environment (typically soil or water). The rate of corrosion is mostly a function of how well the environment conducts electrical current.

The internal corrosion of pipes is managed through a combination of water chemistry adjustments and the use of internal linings.

SPU monitors and controls external (on the soil-pipe interface) corrosion using one of three following methods:

1. Testing the soil environment for resistivity
2. Applying external bonded coatings or polyethylene film encasements (unbonded film)
3. Using a cathodic protection system

See DSG Chapter 6, Cathodic Protection, for detailed discussion of that protection method.

5.6.8.1 Soil Resistivity

Resistivity plays a key role in corrosion control of pipelines. Resistivity refers to the resistance of the environment to electrical current flow. It is the inverse unit measurement used to determine conductivity/corrosiveness of the internal or external environment in contact with the pipe surfaces. By selecting appropriate backfill (soil) or modifying chemical properties of the water being carried within the pipe, resistivity can be adjusted. When resistivity is adjusted, the corrosion rate on pipe surfaces is reduced. See DSG Chapter 6, Cathodic Protection, Tables 6-9, 6-10, and 6-11. When the resistivity of water or soil is high, less current can flow through that environment and the rate of corrosion is lower. For internal corrosion (inside of pipes), water resistivity is constant. For external corrosion (exterior surfaces of pipes), soil resistivity is highly variable. SPU GIS maps show the results of tests taken to date for soil resistivity. SPU staff can test for specific areas for soil resistivity.

For the soil-pipe interface, adjusting soil resistivity is usually neither possible nor practical. Providing select backfill has a short-term effect. Over time, constituents in the soil surrounding the pipe will degrade the backfill and resistivity will approach that of the surrounding material.

Soil corrosivity is based on resistivity measurements of the soil in the pipeline location. Typically, several measurements are taken and an average value is determined. Where soils are very near a classification break point, engineering judgment is required to classify the soil (Table 5-6). Where resistivity tests in one area vary, greater weight is given to the lower values found.

See DSG Chapter 6, Cathodic Protection for Corrosion Protection Requirements for Water Piping Systems.

5.6.8.2 Linings & Coatings

Coating refers to products applied to the outside of pipes. Steel and ductile iron pipelines have different coating requirements. Before selecting a coating system, soil sampling (resistivity testing) should be completed to determine the corrosive nature of the soil.

A. Steel Pipe

All steel pipes must be coated. Several different coating options are available. The design engineer should use best judgment in deciding among coatings. Table 5-7 lists coating types found in the SPU water system in order of use and preference.

Table 5-7
Steel Pipe Coating Types for SPU Water System

Coating	Description
Polyurethane Coating	SPU standard for steel pipe coating. This is a thin film bonded dielectric coating with both water and chemical resistance. It is typically factory-applied and thickness is customized to a specific application. Surface preparation and curing process is very critical.
Fusion Bonded Epoxy (FBE)	FBE is typically applied at the factory on the pipe, and field applied on the joints. Applied by heating the steel pipe, then blowing epoxy in powder form on the heated pipe. Generally considered one of the most durable coatings. Typically most costly.
Paint Coatings	Paint systems work well with cathodic protection systems. Resilient and extremely abrasion resistant. Paint coatings are applied according to AWWA C210 and C218. Commonly used where there is minor damage to the existing coating or the extent of damage is small.
Heat Shrink Wrap Sleeve	Tubular sleeves that can provide effective coating protection around field-welded joints. It is field-applied. Known to be reliable and effective against thermal, chemical, and environmental attack. Economical due to ease of application and no need for primer.
Tape Coating	Historically, this was the most commonly specified dielectric coating system. It has a good performance record at reasonable cost. Typical application includes 80-mil cold-applied plastic tape in three layers over a properly prepared steel surface. However, tape coatings often dis-bond from pipe when pipe is stored in the weather and in presence of sunlight.
Cement-mortar Coating	No longer used, but may be encountered on existing pipes. Chemically protects pipe from corrosion by providing an alkaline environment where oxidation of steel is inhibited. Can be applied in various thicknesses. Provides mechanical protection against handling and installation damage. Typical application thickness is 1".
Coal-tar Enamel Coating	One of oldest methods to provide corrosion protection for steel pipelines. Coal-tar enamel is applied over a coal tar or synthetic primer. Application includes cleaning, priming, application of hot enamel, and covering of a fiberglass matte and/or felt outer wrap. Recommended application includes 7/32-inch coal tar with fiberglass reinforced mineral felt with heat-shrinkable cross-linked polyolefin sleeves at joints.

B. Ductile Iron Pipe

Due to its thickness, ductile iron pipe does not always need a coating. It generally only needs coating when soil conditions warrant. Soils should be tested to identify that need.

For ductile iron pipe, the standard factory coating is an asphaltic coating approximately 1 mm thick. This coating minimizes atmospheric oxidation, but provides no in-ground protection.

Ductile iron pipe must conform to Standard Specification 9-30.2(1).

Table 5-8 lists ductile iron pipe coating options.

SPU requires a double cement mortar lining thickness for ductile iron pipe. See AWWA C104 for more detail on cement mortar linings for ductile iron pipe.

Table 5-8
Ductile Iron Pipe Coating Types for SPU Water System

Coating	SPU Preference
Thermoplastic Powder Coating	SPU standard coating for ductile iron (DI) pipe in a corrosive environment. See <u>Standard Spec 9-30.1(6)C</u> . Can also be used on steel pipe.
Wax Tape system	When used with appropriate primer and a fiber reinforced outer wrap, this coating can protect any buried metal surface, such as bolts, nuts, rods, copper, ductile, or steel.
Polyethylene film encasement (un-bonded film)	Common application for corrosion control. Acts as an environmental barrier to prevent direct contact between pipe and corrosive soils. Not watertight; groundwater can seep beneath the wrap. Integrity depends on proper installation, careful handling by contractor, and inspection by owner. <u>Polyethylene encasement must be per Standard Spec 9-30.1(6) D</u> . SPU has limited success using this product.
Fusion-Bonded Epoxy, Polyurethane, and Tape Coatings	Can be considered as an alternative coating system. Manufacturer has been unwilling to apply bonded coating at factory. Design engineer should recognize potential invalidation of pipe warranty if this is field applied.

C. Linings

Lining refers to a product used to protect the inside of a pipe from corrosion and improve performance and service life. SPU requires a lining for all metallic pipelines. All linings must be National Sanitation Foundation (NSF) 61-approved.

Ductile iron pipe is typically supplied with a double thickness Portland cement-mortar lining per AWWA standard C-104, unless otherwise specified. See Standard Specification 9-30.1(1).

Welded steel pipe is furnished with two primary lining options: cement-mortar or polyurethane. Cement mortar is a nominal thickness of ¼- to ½-inch following AWWA C-205 recommendations for the pipe size involved. For interior linings, polyurethane thickness is typically around 20-mils. See Standard Specification 9-30.1(1).

D. Cathodic Protection

Cathodic protection is a means of providing a sacrificial material to become the point where corrosion occurs. All pipes with bonded coatings especially steel should have cathodic protection.

For a pipeline, cathodic protection provides a separate metal known as a sacrificial anode to be the point where corrosion occurs. This anode protects the pipeline from corrosion. By use of either an impressed current rectifier or materials that are galvanically active (zinc or magnesium), the pipeline becomes the cathode and corrosion is transferred to the anode.

See DSG Chapter 6, Cathodic Protection, for standards for cathodic protection systems.

E. Environmental Modifications

SPU employs corrosion control techniques such as modifying the pH at its water treatment plants to reduce internal corrosion of water pipelines. This practice is controlled by federal regulation under the Safe Drinking Water Act and EPA's Lead and Copper Rule and is a water quality operational methodology beyond the scope of this DSG.

Other engineering practices such as selecting less corrosive soils for pipelines are design considerations for corrosion control.

5.7 WATER SERVICE CONNECTIONS

For standards and guidelines for water service connections, see DSG Chapter 17, Water Service Connections.

5.8 TRANSMISSION MAIN DESIGN

This section describes transmission main design. Transmission mains are major (16- to 64-inch diameter) pipelines within the SPU water system. They convey or transport water from a source to a reservoir and typically do not have any service connections. This section covers the types of materials used, appurtenances, and restraint systems used in transmission main design. For detailed information on water storage tanks, standpipes and reservoir design, see DSG section 5.9.

***Note:** This section of the DSG frequently directs the user to DSG section 5.6, Distribution Main Design. Many of the elements of transmission main design are identical to those for distribution mains.*

5.8.1 Modeling and Main Sizing

See DSG section 5.6.1 for distribution mains. SPU's contracts with its wholesale customers specify the minimum hydraulic gradient or head at each wholesale service connection. The newer wholesale service contracts also specify the maximum flow rate at a given hydraulic gradient that would be provided for each service connection. Any modification to the transmission system should consider these hydraulic criteria. While these hydraulic criteria may be modified if beneficial to the regional system, SPU may make these modifications only once during any 15-year period, provided that 4 years advance written notice is given. At a minimum, transmission mains must be sized to maintain a pressure of 5 psi or more, unless the mains are directly adjacent to the storage tanks.

5.8.2 Location

SPU transmission mains are primarily located in the right-of-way (ROW). However, their design is based on least conflict with other utilities and cost of easements. SPU transmission mains within Seattle are not moved for other utilities. Outside of Seattle, SPU generally owns the transmission pipeline ROWs and mains are typically not moved. An exception is some holdings that belong to WSDOT.

5.8.2.1 Separation from Other Utilities

See DSG section 5.6.2.1.

5.8.2.2 Geotechnical Report

With a new or major refurbishment to transmission main, a geotechnical engineering study must be done for the proposed route (alignment) and documented in a geotechnical report. Consult the SPU Materials Lab for recommendations on what the report should cover. The Materials Lab geotechnical staff must review findings on all projects, even when an outside consultant completes the geotechnical evaluation.

5.8.3 Materials

Transmission mains must be designed to withstand internal working pressure, external loads, and transient pressures. Design should avoid the use of pump stations if possible.

5.8.3.1 Minimum Pipe Size

Transmission mains must be sized to carry the designed peak flow required including fire flow without exceeding the design velocities or head losses.

5.8.3.2 Material Types

A. Pipe

Water transmission mains are typically constructed of steel or class 52 ductile iron. Both ductile iron pipes and steel pipes are to be cement mortar lined in most instances. For more detail on materials for water transmission mains, see Standard Specification 9-30.

Note: SPU does not use pre-stressed concrete cylinder pipe.

See DSG section 5.6.3.2.

B. Casing

See DSG section 5.6.3.7.

5.8.3.3 Pipe Cover

Transmission mains are subject to special pipe strength design considerations and analysis by the design engineer. The minimum depth of cover for water transmission mains is given in the contract for each project. Use AWWA M11 or other applicable design manual to meet the requirements of the project. SPU typically buries transmission mains with 4 feet of cover to allow smaller utilities to cross over the pipeline and to reduce live load on the pipe.

5.8.3.4 Bedding and Backfill

Large thin-walled transmission mains are very susceptible to vertical deflection due to poor lateral soil support. It is essential to keep the trench width as narrow as practical while still permitting compaction at the haunches and sides of the pipe. Over excavation that causes the trench to widen more than a few percent should be discouraged and should be remedied by placement of firmly compacted structural fill in overly-wide trench sections.

See DSG section 5.6.3.4.

A. Standard Trench Section

For detail on a standard trench section, see Standard Plan 350.

B. Controlled Density Fill

See DSG section 5.6.3.4B.

5.8.3.5 Line Pressure

Pipelines must be designed to withstand the required internal working pressure, external loads, and transient pressures.

A. Standard Conditions

Transmission lines do not have a typical operating pressure, but rather operate at the pressures available at every location based on the pipeline's energy grade line, flow velocity and elevation. The design engineer should review the modeling results to determine the maximum operating pressure in the pipeline and design the pipeline system for that pressure as the normal working pressure. Transmission mains must not be designed for less than 100 psig. In cases where there is an extreme pressure differential (e.g. a pipeline following hilly terrain) it may be necessary to change pressure capacity of the pipeline along the pipeline route.

B. Transient Conditions

Transient pressures (water hammer) result from velocity changes in the water flowing through a pipeline. These transient (or surge) pressures can propagate from any non-uniform flow situation like operating a valve, or, an electrical power failure at a pumping facility that causes pumps to shut down, or large, abrupt fluctuations in water demand from major users along the pipeline, or a sudden release of entrapped air from the pipeline. There are many methods to control transient pressures, but the study and design of these controls is best left to professional engineer specialists who understand the dynamics of this issue. Increased harm to the transmission system can be caused by applying incorrect methods of surge control.

Each pipeline material has a typical allowance for surge conditions (typically at 1.5 times the pipeline design pressure for steel or 100 psig for ductile iron). AWWA Manuals may be of assistance to the design engineer when selecting a pipeline surge allowance. Those allowances should then be compared with the maximum surge pressure from the modeling results to ensure the pipeline can withstand the surge pressure. In the SPU Tolt water transmission system, surges of well over 150 psi have occurred after valves were closed too quickly resulting in burst transmission mains. Occasionally, non-destructive surges of over 40 psi have occurred in commercial and industrial areas.

5.8.3.6 Pipe Supports

Transmission lines should rarely be allowed to run aboveground. If that occurs, the design engineer should evaluate temperature differences between the pipe and atmosphere that will affect expansion and contraction at the joints. The issue should be addressed using solutions incorporating expansion joints, pipe insulation, and designing pipe supports to allow movement.

5.8.3.7 Casing

See DSG section 5.6.3.7.

5.8.3.8 Trenchless Technology

Trenchless technologies such as bore and jacking, micro-tunneling, horizontal directional drilling, and pipe ramming are alternative methods of construction to the more typical cut-and-cover. Typically, trenchless technology is considered to avoid environmental or construction impacts. Before considering trenchless technologies, the design engineer should rule out alternatives. Every trenchless project is unique and requires custom evaluation and analysis. Items to consider include topography, soil conditions, regulatory issues, and site constraints.

A. Bore and Jacking

Bore and jack installation (also called horizontal auger boring) consists of installing a casing by jacking and concurrently auguring the soils out through the casing. Alignment is fairly accurate with bore and jacking. However, there can be potential problems with high ground water and excessive lengths. Once the casing pipe is installed, the carrier pipe is installed with spacers to support the pipe. The gap can be filled, typically with blown sand or a non-shrink grout.

B. Micro-tunneling

Micro-tunneling is typically a closed-face pipe jacking process. Micro-tunneling requires both launching and receiving shafts, which are typically constructed out of slurry walls. Micro-tunneling machines are laser controlled remotely from the surface. Micro-tunneling installs a casing pipe, and then a carrier pipe is installed. Because this process allows precise grade control, it is frequently used in water and sewer applications.

C. Horizontal Directional Drilling

Horizontal directional drilling (HDD) consists of drilling progressively larger diameters from ground surface to ground surface in an arch under the obstruction. No shafts are constructed with HDD construction. Typically, the first pass of a drilling operation creates the route. The pipeline route is then increased in diameter by forward and back reaming the drill path. The hole is kept open with drilling fluids, typically a bentonite slurry. During drilling, various methods are used to track the drill bit and determine the route. Recent history has shown HDD pipeline installation to be relatively accurate. Once the desired diameter is achieved, the carrier pipe is pulled through the drilled path. No casing pipe is used in HDD applications.

D. Pipe Ramming

Pipe ramming consists of using a hydraulic hammer to push the pipe through the soil. Once the casing pipe is installed, the center channel is removed, typically by an auger method or compressed air. With small diameters, the carrier pipe may be rammed with a closed end. Frictional forces can limit the overall length of the pipe ramming, and there is no line or grade control.

5.8.3.9 Restraint Systems

See DSG section 5.6.3.9.

5.8.3.10 Chambers (Vaults)

See DSG section 5.6.3.11.

5.8.3.11 Appurtenances

Pipeline appurtenances, such as line valves, access ports, blowoff/drains, or air release/air vacuum valves should be provided along the pipeline as needed to support the transmission main function and operation. Appurtenance locations should be determined to avoid conflicts with other structures, vehicular traffic, existing utilities, and locations vulnerable to damage or vandalism. See DSG section 5.6.4.

5.8.3.12 Line Valves

Each transmission main project should examine the proposed route for the best location of isolation line valves. Consideration should be given to future operational issues such as draining the pipeline and isolating a mainline break. SPU recommends placing isolation valves at least every 2,000 feet and at every intertie location. All line valves should be installed within a chamber per the standard line valve chamber detail in the DSG (see Figure 5-5).

5.8.4 Seismic Design

This section describes seismic requirements for water system design.

5.8.4.1 Critical Needs Assessment

The purpose of a critical needs assessment is to establish design requirements to provide for the highest level achievable for continuity of service, i.e. for the transmission pipeline to function within its design limits with as little service interruption as possible. A critical needs assessment of the proposed new or refurbished transmission main and associated facilities should be completed as part of the basis of design. From the critical needs assessment, design criteria should be clearly established for the following:

- Design operational life of the transmission main.
- Maximum length of time that the transmission main can be out of service for repairs or maintenance without negatively affecting the water demand requirements. Identify seasonal considerations that affect the length of time the main can be out of service.
- Redundancy of critical components or functions, such as line isolation valves.
- Accessibility for the transport of repair and maintenance equipment.
- Access to the interior of pipes, vaults, and other structures for inspections and repairs.
- Impacts from geologic events (landslides, erosion) and seismic events (ground movement), including:
 - Foundation and backfill requirements
 - Drainage and control of, or protection against, groundwater
 - Allowable pipe movement
 - Allowable joint leakage (if any)
 - Need for and location of seismic valves

5.8.4.2 Seismic Joints and Connections for Pipe Movement

This section describes potential design issues when SPU water pipes must cross settlement prone areas, faults, liquefaction zones, slides, or where two types of pipe with different restraint characteristics must be connected. In both cases, design must allow pipe movement.

A. Cast Iron Pipe

Much of the SPU Water System piping is non-restrained, inflexible cast iron pipe with lead joints. No matter how robust a system design may be for crossing a given fault or landslide zone, if a connection to the existing pipe is faulty it will fail when the ground moves. Either of two methods will stabilize the structure within the zone:

1. Extend flexible restrained joint pipe a significant distance beyond the fault/slide zone.
2. Install some immovable structure on the new flexible restrained pipe near its connection with the existing pipe.

B. Ductile Iron Pipe

Where smaller ($\leq 24"$) diameter pipes cross movement prone areas, they are usually ductile iron. The options are:

- **Standard Flexible Restrained joint pipe with expansion fittings such as a restrained telescoping sleeve.** A telescoping sleeve allows axial elongation of the piping system.
- **Restrained Ball Joint pipe with expansion fittings such as a restrained telescoping sleeve.** Ball joint pipe is the most flexible and the most expensive pipe available. The balls must be encased in polyethylene encasement to keep dirt out of the ball. See Specification 7-11.3)(6)B
- **Standard Flexible Restrained joint pipe with double ball expansion joints placed where the most differential movement is expected.** Flexible Single/Double Ball Expansions Joints are discussed in DSG section 5.6.3.9E. Currently these fittings are only available up to 48-inch diameter. Standalone single ball joints are available at 72 inches as well. The large-diameter sizes are extremely expensive.

See [Appendix 5B](#) for the allowable ductile iron deflections. In all of the options above, shorter sections of pipe with extra joints can be used to provide more pipeline flexibility.

C. Steel Pipe

Where larger ($\geq 24"$) diameter pipes cross movement prone areas, they are generally steel. Steel pipe is somewhat flexible and the nature of the material allows it to yield and elongate significantly before failure. Some studies indicate that good welds can elongate 20% before failure. However, bending and buckling of the steel pipe can be a problem when the settlement trough is not smooth. Best options for steel pipes are:

- **Full penetration butt welded steel for heavier wall thickness than normal.** See DSG section 5.6.3.9B.1). Steel pipe with no special fittings works well for long smooth settlement troughs. See Virtual Vault plan set [774-569](#) for an example of a 24-inch butt welded steel pipe with several design features included to increase seismic survivability of the system in a liquefiable zone.
- **Full penetration butt welded steel with expansion fittings.** Large-diameter steel expansion sleeves are available, but offer little expansion or deflection capability. If possible, double ball joint expansion fittings should be installed if large differential ground movements are expected. Due to their current limited

range of available sizes, steel pipe size may need to be reduced in the immediate vicinity of the ball joints. See Virtual Vault plan set 785-38 for an example of an 89-inch OD steel pipe crossing a slide plane with a 48-inch double ball expansion joint.

Where fault crossings/slide planes are encountered, a double ball expansion joint should be installed right at the fault crossing as shown in Virtual Vault plan set 785-38. If this is not possible, the thickest pipe wall and strongest steel should be used in combination with loose backfill, minimal overburden, and with some flexibility built in elsewhere if possible.

Design considerations such as predicted ground movement, installation cost, cost of failure, and reliability must be analyzed. Some SPU pipelines are extremely critical and must be designed to withstand the largest expected ground movement.

5.8.4.3 Seismically Actuated Valves

Seismically actuated valves automatically close during an earthquake to prevent the uncontrolled drainage from water storage tanks due to broken downstream pipelines. Many factors must be determined for each valve installation: sensitivity, speed to close, battery life requirements, power availability, and SCADA.

The seismic actuator must be properly matched to the valve it protects.

All valves must have a manual operator for emergency operation.

5.8.5 Inter-Connection of Parallel Mains

In some cases, pipelines may be installed parallel, or a new line may be installed near an existing main. The design engineer should consider whether a connection between the two pipelines is possible and beneficial. A primary reason to consider the interconnection is draining of the pipelines. Typically, when a pipeline is drained, millions of gallons of water are wasted. Pumping from pipeline to pipeline allows for faster draining than can normally be achieved by draining to the waste water system or a body of water. If parallel or nearby pipelines are interconnected, water from the pipeline to be drained can be pumped into the other pipeline, thus not wasting water.

The interconnection between mains will likely require room for a pump. If possible, route an interconnection line from each pipeline into a single vault, leaving a gap for a pump and the final connecting piping. The size of the interconnection should be based on flow calculations and an acceptable amount of time to drain the line. A good location for an intertie is at the blowoff.

5.8.6 Rehabilitation of Existing Mains

See DSG section 5.6.5.

5.8.7 Emergency Pump Connections

See DSG section 5.6.6.

5.8.8 SCADA

See DSG section 5.6.7.

5.8.9 Corrosion Control

See DSG section 5.6.8.

5.9 WATER STORAGE TANKS, STANDPIPES AND RESERVOIR DESIGN

This section describes water storage facility design. Water storage facilities primarily function to provide adequate flow and pressure for all design conditions where the transmission and distribution system cannot otherwise maintain the flow or pressure required. Water storage tanks, standpipes, and reservoirs are critical infrastructure that directly influences public health and safety. These SPU facilities must be designed and operated to prevent cross-contamination of water and degradation of water quality. For more detail on SPU reservoirs, see *DSG Chapter 13, Dam Safety*.

5.9.1 Planning

Planning includes determining the facility's general characteristics, size, location, and a timeline for service based on hydraulic modeling and demand projections. If approved by SPU management, a storage facility project is incorporated into the Capital Improvements Program (CIP) plan.

5.9.1.1 Service Life

A. Concrete Reservoirs

For new concrete water storage reservoirs, service life must meet the specific project requirements. Most water utilities use a typical service life of not less than 50 years for concrete structures. For refurbished existing concrete water storage reservoirs, the design service life will be established case-by-case based on the specific conditions and requirements for the reservoir.

B. Steel Storage Tanks

For new steel water storage tanks, most water utilities use a design life of 75 or more years, assuming that the coatings are well maintained. An economic analysis of coating and cathodic protection systems should be done to determine the most cost-effective method for preventing corrosion. For refurbished existing steel water storage tanks, design service life is established case-by-case based on specific conditions and requirements for the tank.

5.9.1.2 Hydraulic and Capacity Requirements

Generally, the size of a finished water storage facility must provide sufficient capacity to meet both domestic demands and any requirements for fire flow.

Specific capacity requirements must meet the applicable elements of the Washington State Department of Health Water System Design Manual or SPU's system reliability criteria under defined emergency scenarios, whichever is less. Storage facilities are expensive to construct, operate and maintain, plus they increase the water age and as such should not be unnecessarily oversized.

Capacity must be established and documented by an engineering study using the following basic criteria:

- The planning horizon for demand projections must be not less than 20 years. For new facilities, the planning horizon should be 50 years or more.
- Volume should be sufficient to deliver design peak hourly demand at 30 psi to the pressure zone served. This volume requirement may be reduced when the source water facilities have sufficient capacity with standby power for pumping to the reservoir and/or when another storage reservoir can be used to supplement peak demands of the zone. During fire flow conditions, the combination of storage and delivery system capacity must be adequate to provide water at the required flow rate and a minimum 20 psi in the main.
- To determine the emergency /standby storage component, identify the reasonable emergencies, define the duration and level of service during the emergency, then apply SPU's reliability criteria as described in the current Water Supply Plan.
- Water quality impact of storage and design considerations to enable regulatory compliance throughout the life of the facility.

5.9.1.3 New or Modifications/Expansions of Existing Storage Facilities

A. General Considerations for New Facilities

The following are general considerations for planning and preliminary design of new storage facilities or for modifications, expansions of existing facilities, retirements of facilities or downsizing facilities:

- Hydraulic grade line of the water supply system
- Pressure zones served by the storage facility
- Sizes and capacities of transmission or feeder mains and, where applicable, booster pumping stations, that supply the storage facility (existing and future)
- Sizes and capacities of distribution mains in the pressure zones served by the storage facility (existing and future)
- Availability and type of discharge points for overflow and drain water from the storage facility
- Geotechnical and seismic characteristics
- Vehicle access for all anticipated vehicle and equipment types
- Security
- Fire services (fire flow, emergency engine fill points post-earthquake)
- Land ownership and future use by City of Seattle departments
- Environmental impacts to adjacent properties

- Multi-use site considerations (e.g. public access, recreation, memorandum of agreement addressing maintenance and use on reservoir sites and sites adjacent to reservoirs)
- Anticipated future development of adjacent properties

B. Communications Equipment

Antennas and other communications equipment can be mounted on a separate tower on the site or on a storage facility. If antennas or communications equipment are mounted on the storage facility, proposals must include structural and wind-load engineering calculations demonstrating the tank can safely accommodate the additional weight of equipment and cables. SPU Real Property is the lead for communicating with tenants and issues the permits for use of SPU property.

Calculations must factor in other equipment already installed on the tank. Equipment should be clamped to the facility rather than welded when possible, to avoid damage to interior and exterior coatings.

Note: It is extremely important to ensure that the interior coating of the tank is undamaged either by welding or by an activity that may jeopardize the interior lining or the exterior coating. The repair cost of such damage is significant.

C. Location of New Facilities

Location of new storage facilities should consider site features and constraints that affect the sanitary and structural integrity of the facility:

- Drainage of site and structure
- Locate storage facilities at least 50 feet from the nearest potential source of contamination
- For above-grade facilities: foundations should be at least 3 feet higher than the 100-year flood elevation
- For below-grade facilities:

At least 50% of reservoir or tank should be above highest point of groundwater table

Accessible vents and hatches should be at least 2 feet above normal ground surface. Grade should slope away from the reservoir. Access points and vents are located above the 100-year storm elevation

- Proximity to closest sanitary sewer and storm drainage mains
- Overflow route

5.9.1.4 Operations and Maintenance (O&M) Requirements

A. Routine Operations

At a minimum, each water storage facility must follow water supply and quality goals for operational procedures common to all facilities as shown in Table 5-9.

Table 5-9
Sample Requirements for Routine Operation of Water Storage Facilities

Parameter	Requirement	Comments
Pressure Maintenance to Zone Served:	30 psi	Maintain 30 psi under peak hourly demand conditions Maintain 20 psi under fire flow conditions
Minimum	20 psi	
Drawdown and Filling	Typical draw between 8 AM and 5 PM Typical fill between 8 PM and 5 AM	Draw and fill cycles for some storage facilities may vary from this objective to meet other requirements. Note: These times are a starting point. Drawdown occurs during day and fill overnight as a general rule
Water Age (turnover rate)	5-7 days	Longer water ages may be acceptable for some storage facilities based on chlorine residual data, water mixing systems and ease of chemical injection
Operational Volume	As required to meet seasonal demands, pressure requirements, and water age targets	Operational volumes will vary seasonally for many of the storage facilities
Sample Collection	Easily accessible sample port enclosed in cabinet	Sampling may be required at different elevations within the tank
Supervisory Control and Monitoring	Water elevation Overflow indication Inlet and outlet metering	
Manual Booster Chlorination at Elevated Tanks and Standpipes	Easily accessible injection port enclosed in cabinet	Injection occurs on fill cycle.

B. Emergency Operations

The following are minimum design requirements for operation of water storage facilities under emergency conditions that can result in loss of power or a water quality condition that could be harmful to health:

- Maintain at least one storage cell on-line if facility has two or more storage cells. If the facility is a single cell, maintain at least 50% of the volume online
- Fill all storage cells
- Draw from at least one storage cell to meet emergency demands for at least (as required) hours
- Hydraulically isolate all storage cells from the supply and distribution system
- Complete drain-down of a storage cell as specified in the basis of design
- Inject a solution of treatment chemical
- Collect a water quality sample from an easily accessible collection point

5.9.2 Water Storage Facility Structures

The following are the primary structural functions of a water storage facility:

- Remain as water tight as achievable for the design seismic, geotechnical, and thermal conditions over its design life
- Survive the design seismic event so that its operational purpose (fill, storage, and draw of potable water) is maintained
- Maintain the sanitary integrity of the tank so that its water quality is not compromised.

The following are general design requirements for structural and material design elements of storage facilities to meet the above requirements. All elements must be evaluated and addressed to establish the basis of design for every new or refurbished storage facility.

5.9.2.1 Geotechnical and Seismic Requirements

The following are SPU standards:

1. A geotechnical study must be performed before design of any new or structurally refurbished storage facility. Soils and groundwater characteristics for each site are unique, so the geotechnical study must be tailored accordingly.
2. The methods, findings, and recommendations of the geotechnical study must be documented in a geotechnical report.
3. The structural design requirements of storage facilities must address specific seismic criteria for Essential Structures per the Seattle Building Code (SBC) and AWWA D-100.
4. Perform seismic design with considerations for soil-structure interaction.

The following are guidelines for the geotechnical report:

- Identification of previous geotechnical work for the storage facility site and the key observations and conclusions from the previous work.
- A detailed description of subsurface soils and groundwater conditions.
- Identification and descriptions of known geologic hazards, including seismic, steep slopes and landslides, erosion, and contaminated soils hazards
- Identification of locations for additional field explorations/borings, if needed.
- Conclusions and recommendations for design, including geologic hazards, seismic criteria (e.g. probabilities of peak ground acceleration), excavation and shoring, dewatering, foundation and backfill requirements, erosion and sedimentation control measures, and hazardous materials.

5.9.2.2 Structural Materials

A. Concrete Reservoirs

Two primary issues for concrete storage reservoirs must be addressed in design:

1. Corrosion of exposed reinforcing steel and corrosion caused by use of dissimilar metals, such as stainless steel ladders adjacent to mild steel, either coated or embedded.
2. Foundation failure due to settlement or leaks causing undermining of the foundation.

The alkalinity and pH of cement materials can cause deep cracking on the interior of the facility and may expose the reinforcing steel to air and moisture, resulting in corrosion. As reinforcing steel corrodes, the integrity of the structure will weaken and eventually fail if not repaired.

Cracking in walls roofs and floors, failed expansion joints, failed water stops, are also common concerns with concrete reservoirs that should be addressed in design.

For concrete reservoirs, the following AWWA standards must be applied:

- D110 – Wire- and Strand-Wound, Circular, Pre-stressed Concrete Water Tanks
- D115 – Circular Pre-stressed Concrete Water Tanks with Circumferential Tendons.

B. Steel Tanks

The structural integrity of steel storage tanks is primarily affected by corrosion. Corrosion can attack specific portions of the tank and cause significant structural problems.

For steel tanks, the following AWWA standards must be applied:

- D100 – Welded Steel Tanks for Water Storage

5.9.2.3 Coatings

For steel tanks, the following AWWA standards must be applied:

- D102– Coating Steel Water Storage Tanks

5.9.2.4 Liners

For liners and floating covers in contact with potable water, the following AWWA standards must be applied:

- D130 – Flexible-Membrane Materials for Potable Water Applications.

5.9.2.5 Corrosion Control Systems

If used for steel tanks, the following AWWA standards must be applied:

- D104– Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks.

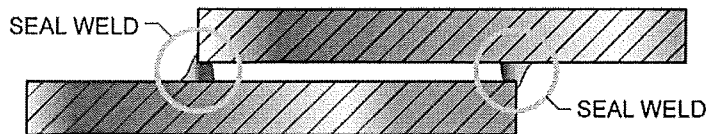
Note: As of June 2015 SPU only has impressed current cathodic protection on the Trenton Stand Pipes and has a sacrificial cathodic protection system on the Foy Stand Pipe. On well coated tanks, sacrificial cathodic protection systems are preferable. The design engineer should consult with a corrosion control specialist and evaluate the following:

- Conditions above and below the water level
- Fasteners and appurtenances located within the tank.

Surfaces exposed to fluctuating water levels and the undersides of roofs are particularly at risk, yet they receive little benefit from cathodic protection. Proper coating systems are critical for these surfaces. Do not use dissimilar materials inside the tank (e.g. steel structure and stainless steel ladders).

Seal weld all adjacent metal to avoid corrosion between the plates (see Figure 5-22). If this is not done, corrosion will form between the plates, and there will be no access for surface preparation or coatings in the future.

Figure 5-22
Seal Welds



For more detail on corrosion control systems, see *DSG Chapter 6, Cathodic Protection*.

5.9.2.6 Demolition

Demolition of other structures or buried utilities adjacent to or below a water storage facility's foundation or footings requires careful consideration to avoid damaging the foundation, footings, or yard piping associated with the facility. Before design of demolition, geotechnical and structural analyses should be done to determine potential impacts of the proposed demolition to establish a basis of design for their protection. For information on demolition permit requirements, see *DSG Chapter 2, Design for Permitting and Environmental Review*.

5.9.2.7 Configuration and Control for Service Reliability

The configuration and control for service reliability should consider the number of cells and flow control.

A. Number of Cells

To the extent practicable, new or refurbished facilities should have two or more cells to provide for greater reliability/redundancy.

If it is determined that a single cell meets the project requirements, it should be a dual outlet system. The lower outlet typically uses an earthquake/seismic valve.

B. Flow Control

The following are the minimum flow control requirements for storage facilities:

- Isolation valves on inlet and outlet lines that can be controlled locally and via SCADA.
- Piping and valves to provide for the bypass and drainage of the storage cell.

5.9.3 Hydraulic Mixing for Water Age and Water Quality Control

To prevent hydraulic dead zones and excessive water ages within a storage tank or reservoir, there must be a means for complete hydraulic mixing throughout the entire volume of the storage cell. The configuration and sizes of inlet and outlet pipes to the cell have a direct impact on the degree of hydraulic mixing achievable.

Each storage cell should have a volume in which water age (hydraulic detention time) is not more than 5 days at projected average water demands when the reservoir operates at full capacity. The goal is to keep total water age through the reservoir to no more than a 5-to-7-day range.

The Water Research Foundation publication, *Maintaining Water Quality in Finished Water Storage Facilities*, describes design considerations and features for controlling water quality in storage facilities.

5.9.3.1 Inlet and Outlet Pipes

Generally, a separation of the inlet and outlet points within a storage cell will enhance mixing and help avoid water quality problems associated with dead zones and short-circuiting. For ground tanks, this is done by locating the inlet discharge near the perimeter of the cell with an upward bend. The tank outlets are then placed into the center of the tank floor. In elevated tanks, inlet and outlet points are separated one of two ways:

- Bring separate inlet and outlet lines up through the tank.
- Split the line in the riser and use check valves to introduce water into the center of the tank near the top of the water column. In this option, the outlet pipes are placed at the tank perimeter with a vertical separation to the inlet elevation of not less than about $\frac{1}{2}$ the total cell height.

Proprietary pipe and valve systems for storage facilities can be specifically designed based on the momentum mixing principle. The Red Valve Company system has gained widespread use.

For smaller tanks (less than 0.5 million gallons), the inlet and outlet may not need to be separated. Smaller tanks have smaller volumes, which allow adequate momentum for mixing.

A. Inlet Pipe

The inlet pipe should be as small as practicable to maximize inlet velocity to provide for adequate momentum mixing throughout the storage cell to preclude hydraulic short-circuiting. Reductions of inlet diameter have also been retrofitted on existing SPU tanks during tank renovation by using a reducer on the discharge end of the inlet pipe.

B. Outlet Pipe

In single-cell ground level reservoirs, each storage cell should have two outlet pipes, one near the mid-level and the other near the bottom of the cell. Both outlets should have isolation valves. The mid-level and lower outlets remain open for normal operation. The lower outlet should have a seismic valve that closes automatically during an earthquake to prevent the cell from draining past the mid-level.

In double-cell ground level reservoirs, outlets should have seismic outlet valves that close automatically during an earthquake to prevent the cell from draining. Typically, one seismic valve will be disabled to make half of the stored volume available for fire-fighting purposes, while the other seismic valve will close to retain water for future use.

5.9.3.2 Sizing Inlet Nozzles for Momentum Mixing

The inlet pipe and nozzle to each reservoir cell should be sized to provide a velocity of the entering water to enable complete hydraulic mixing throughout the entire cell. Typical time to mix the cell should be 4 to 6 hours at the designed inlet flow rate for lower-demand periods.

5.9.3.3 Mechanical Mixing Systems

If adequate momentum mixing cannot be achieved using inlet jet velocity (due to flow rates in relation to reservoir cell size), consider enhancing using a mechanical method. The following are three mechanical mixing methods:

1. **Pumped recirculation.** This system features a pumped recirculation loop with the suction line from the reservoir and the discharge line entering the reservoir through a single or multiple ports.
2. **Mechanical mixers within the reservoir**
3. If higher-pressure water is available, consider a **gravity hydraulic mixing system** that pipes the higher pressure water to the tank and mixes through a series of nozzles attached to a riser pipe in the tank.

A. Recirculation

- Recirculation systems should be designed for continuous pumping. A general estimate for recirculation pump sizing is 1 hp per million gallons of storage volume.
- Provide at least two pumps for full redundancy.
- To the extent practicable, select pump sizes and types that are compatible with recirculation pumps at other reservoirs so that pumps are interchangeable and can be used as replacements or spares.
- The recirculation grid size depends on the size of the storage cell, but should extend to cover all areas of the cell. Pipe sizes for these grids are typically 4 to 6 inches in diameter.
- Orifice sizes and spacing are designed to achieve the velocities necessary for adequate localized momentum mixing. Typically, the range of velocity needed is 8 to 10 fps at the orifice discharge.
- Provide an easily accessible sample collection point on the recirculation piping.
- Provide an easily accessible chemical injection point on the recirculation piping.

5.9.4 Water Level and Flow Measurement

- Each storage cell must have provisions for online measurement and recording of water levels between the top of the outlet sump and overflow levels.
- Provide a totalizing meter on the outlet side to accurately measure demand from the reservoir.

- Provide a totalizing meter on the inlet side to accurately measure flow into the reservoir.
- Provide positive online indication of overflow.

5.9.5 Mechanical Appurtenances and Equipment

This section describes mechanical appurtenances and equipment for water storage facilities.

5.9.5.1 Location

To the extent practicable, mechanical appurtenances such as valves, pumps, and controls should be located in clusters. If applicable, they should be located in mechanical rooms or vaults for ease of maintenance and security.

5.9.5.2 Penetrations to Storage Cells

Penetrations for pipes, hatches, vents, and sensors into storage cells require special design considerations to preclude the intrusion of contaminants. The following are general considerations for mechanical appurtenances and equipment that penetrate storage cells:

- Materials and coatings of appurtenances should provide for high resistance to corrosion.
- Open ends of vents on ground level reservoirs should be oriented downward and provided with 24-mesh, corrosion resistant screens. Duckbill check valves may be used on overflow piping or vents where there is potential for a large volume discharge.
- Open ends of vents on elevated tanks and standpipes must open downward, and either be fitted with 4-mesh screen, or with a finer mesh screen in combination with an automatically resetting pressure-vacuum relief mechanism. Duckbill check valves may be used on overflow piping or vents where there is potential for a large volume discharge.
- Wall and roof penetrations are welded on steel tanks and equipped with seep rings on concrete reservoirs.
- Valve stem penetrations must be sealed to prevent entry of contaminants.
- Materials used at penetrations must be selected to avoid creating galvanic currents between dissimilar metals.

5.9.5.3 Vents

- Vents should be located at least 2 feet above finished grade or the 100-year flood elevation, whichever is greater.
- Vents must be sized to allow for adequate air intake assuming restricted flow through dirty bug screens during rapid drawdown of the water level such that the maximum pressure drop within the storage cell does not impose structural stresses. The acceptable maximum pressure drop is a function of structural materials and configuration of the storage cell. Acceptable maximum pressure drop must be established by a design engineer or manufacturer.

5.9.5.4 Overflows

The following are SPU standards for overflow pipes:

1. Overflow pipes must be sized to accept flow rates equal or greater to the maximum inflow rate to the storage cell.

2. Overflow pipes must terminate at an air gap (see DSG sections 5.6.4.3 & 5.6.4.4), and should be easily visible to O&M staff. **Do not put valves on the overflow pipe.**
3. The surface below the air gap must slope away from the storage cell and direct the flow to a sump or catch basin from which the flow is conveyed to the designated discharge point.

The following are guidelines for overflow pipes:

- If the overflow water enters a sewer, check sewer pipe hydraulics for any constraints to accepting the design overflow rate.
- If the overflow water can enter a natural stream or pond directly from the discharge point, a passive dechlorination system should be installed. For example, a passive dechlorination system is a catch basin within which bags of a dechlorination chemical (ascorbic acid or sodium thiosulfate) are placed. The overflow water is passed through the dechlorination structure before discharge to the receiving water body.
- In addition to a screen, consider installing a flap gate at the end of the overflow pipe to prevent animal access. A duckbill valve may be used in place of a screen and flap gate to prevent animal access. The duckbill should be recessed within a pipe to discourage vandalism.

***Note:** Overflows usually go to a reservoir's dedicated storm drain line. This line must also be capable of the flow rate. The receiving water body must likewise be able to receive this flow rate.*

5.9.5.5 Connections

Connections between the storage cell structure and pipes external to the structure (either exposed or buried pipes) should allow for longitudinal expansion and lateral movement that occurs during earthquakes and through long-term differential settlement. Pipes located under ground-level reservoirs should be encased in reinforced concrete to minimize future maintenance.

5.9.5.6 Hatches

The following are SPU standards for water storage hatches:

1. All access hatches not bolted to the main structure must be lockable and provide intrusion switches linked to the SCADA system.
2. Hatch lids covering openings to water storage facilities must be designed to prevent drainage runoff from entering interior of the hatch and/or accumulating next to the hatch area. This also provides protection from ice damage. For hatches with raised curbs or frames, the lid should overlap the curb/frame.

The following are guidelines for hatches:

- For accessible ground-level hatches to concrete reservoirs, the hatch should be designed either to lock or to accommodate a 600-lb block or lid on top.
- Hatches manufactured by LW Products or Bilco have typically met SPU requirements.

- Hatches installed in graveled areas should be raised above grade to prevent gravel from becoming lodged and jammed between the frame and the lid, or becoming lodged in the locks.

5.9.5.7 Access Ladders and Catwalks

- Fall protection equipment must be provided.
- Select material and coatings to provide for high resistance to corrosion and graffiti.
- For above grade facilities, entries to ladders or catwalks should be elevated at least 10 feet above grade and have a lockable gate or door. The gate or door must be designed to allow for safe access from a cherry picker or similar.
- For internal stairs or catwalks over finished water, the steps should be solid plates with raised edges to help prevent dirt from entering the water.

5.9.5.8 Mechanical Rooms and Vaults

- Provide for proper interior drainage within the valve chamber, including floors sloped to drains and/or sumps.
- Provide for perimeter drainage.
- Top of chamber should be at least 1 foot above finished grade.
- For access hatches and vents to valve chambers, see DSG section 5.9.5.6.

5.9.5.9 Storage Cell Drainage Equipment and Features

- Cell drainpipes must not be cross-connected to a storm or sanitary sewer line. They also need an air gap or backflow prevention device.
- The floor of a storage cell should be sloped to enable drainage to a single sump.
- If feasible, the sump should have a pipe that drains via gravity to the designated cell drain point with an air gap. The sump should be sized to accommodate a portable sump pump, even if there is no drainpipe.
- Size drain pipes to accept flow rates such that the cell can be drained in the minimum amount of time without exceeding the capacity of the discharge point.
- Control valves for drainpipes should be easily accessible. Wherever possible, the location of drain valves should be within the valve chamber for the storage facility.
- Provide a removable mud/silt stop at the upper edge of the sump, or located to prevent discharge of sediments into the outlet and drain pipes.

A. Roof Drains

- Roofs must be watertight and sloped for drainage.
- Roof drains must be connected to a permitted drainage system.
- Roof downspouts must be external and not mounted within the storage cell. None of the drain system should be within the storage cell.
- Domestic water and stormwater must not co-mingle.
- SPU requires certain Green Stormwater Infrastructure (GSI) elements be incorporated into structural design of new projects. For more information on GSI, see DSG Chapter 8, Drainage and Wastewater Infrastructure, section 8.7.8.

5.9.6 Multi-Use Facilities

Where a storage facility is to be integrated with other recreational uses (e.g. tennis or basketball courts), grass-covered recreational areas, or parking lots special consideration should be given to physical and sanitary security issues. Storage facility design should address the following:

- Locate hatches to storage cells and valve chambers that are physically separate and secure from public areas, but visible from adjacent streets to enable observation by law enforcement or security personnel.
- Provide physical security to intrusion for hatches, tank ladders and doors to valve chambers or other enclosures.
- Provide appropriate signs that clearly indicate areas that are for authorized personnel only.
- Provide lighting fixtures and features that give the necessary level of lighting for security without negative impacts to adjacent public areas. Lighting fixtures should be designed so that the wiring and/or bulbs are not exposed or easily accessed to preclude inadvertent damage or vandalism.

Refer to the current agreement between Seattle Parks and Recreation and SPU for specific items associated with multi-use reservoir sites.

5.9.7 Landscaping and Weed/Pest Control

For detailed information on landscaping and weed and pest control, see *DSG Chapter 4, General Design Considerations*.

5.9.8 Access and Security

5.9.8.1 General

The following are general considerations:

- Include SPU Security Plan requirements for general security and security design requirements for water facilities.
- If the storage facility site is not open for public use, provide a means of controlled access around the entire perimeter. If the site will be open for public use, provide a means of controlled perimeter access around the hatches, vents and vaults.
- Provide security alarms at access doors or hatches tied into the SCADA system.
- To the extent practicable, do not allow site features where unauthorized persons or materials can be easily concealed, such as structures, trees, or vegetation.

5.9.8.2 Personnel Access and Safety

A. Access

The design of access features for storage facilities should address the following:

- Vehicular access to hatches and ladders is required and must be sized to accommodate the size of the vehicles normally used in maintenance or inspection of the facility.
- Ladders, stairways, and catwalks designed to conform to OSHA requirements.
- Hatches placed to facilitate ease of maintenance and cleaning.
- Hatches sized to accommodate access for personnel with tools, inspection divers, and remotely operated vehicle (ROV) inspection/cleaning equipment. For larger facilities, this requirement typically results in one or more large equipment hatches, through which field equipment can be lowered, and one or more personnel access hatches.
- Provide ladders or stairways inside of storage cells.
- Ladders should be caged and have climbing or fall protection.

B. Egress and Emergency Escape

The following are egress and emergency escape features:

- Provide internal and external restraint support/safety equipment.
- Ensure unobstructed clearances to access/egress points.
- Provide any other features necessary to meet requirements associated with confined-space entries.

5.9.8.3 Operations & Maintenance

A. Lighting

Permanent lighting fixtures should be provided to light hatch doors into storage cells and vaults and to provide visibility to the local work area perimeter.

Permanent lighting fixtures should be provided to provide a minimum acceptable level of lighting within storage cells and vaults for routine inspections and maintenance.

Power outlets should be easily accessible to all hatches for the operation of temporary lights within storage cells and vaults.

Convenience outlets should be within 6 feet of all mechanical equipment.

B. Ventilation

Hatches to storage cells and vaults should be located to accommodate temporary ventilation equipment, including points for the introduction and exhaust of ventilation air.

To the extent practicable, power outlets should be easily accessible to all hatches to facilitate the operation of temporary ventilation equipment.

Permanent ventilation system should be capable of eight exchanges per hour at all times.

C. Communication System

Determine the methods of communication to be used by personnel during facility maintenance (e.g. radio, wire intercom) and provide appropriate equipment or appurtenances for their use.

At a minimum, provisions for antenna mounts are one mount for every two communications lines. If there is only one communications line, then one mount is needed. Locations of the mounts are site specific. Roundup spare conduits for future installation should be considered.

5.9.9 Water Quality Monitoring/Sampling

At a minimum, water quality should be monitored every 2 weeks. At automated chlorine injection locations, remote monitoring should be continuous. The following should be continually monitored:

- Chlorine residual
- pH
- Temperature

Total coliform (TC) and heterotrophic plate count (HPC) should be routinely monitored, at least twice per month. Other parameters may be measured case-by-case, depending on operational circumstances.

5.9.9.1 Sampling Points

At a minimum, design must provide sample points for withdrawal of water for continuous online measurement of chlorine residual, pH, and temperature at the following locations:

- Inlet to each storage cell
- Outlet from each storage cell

Provide sample ports from which to obtain manual grab samples for any type of analyses at the following locations:

- Inlet to the storage cell
- Outlet from the storage cell
- From varying depths of the storage cell, at a minimum from the top (75% level), middle (50% level), and bottom (20% level) of the cell.
- If possible, in the center of the storage cell. (Center point sample line installation may require adding a small support structure to keep the lines from breaking.) The in-tank sample lines can be used to collect coliform samples after tank disinfection.
- If the extent of the horizontal footprint of the storage cell is large relative to the vertical height, add one or two additional locations across the cell in addition to the center point.

Sample ports should be easily accessible without the need to open hatches to the storage cell. Where practicable, the pipes from all sample ports should terminate at a single sampling station

within a lockable cabinet at or near ground level outside the storage cell or within the valve chamber.

5.9.10 Disinfection and Dechlorination

SPU uses portable ascorbic acid dechlorination units for all dechlorination operations. The drain-down pipe from each storage cell must have a liquid chemical injection station for direct injection of ascorbic acid.

5.9.10.1 Booster Disinfection

Historically, SPU water storage facilities have received booster disinfection (chlorination). Booster chlorination may need to be considered for some existing storage facility sites should chlorine residual maintenance become a problem or a potential problem. Booster chlorination should be incorporated for new storage facilities located near the periphery of the distribution system where water demands may be initially low.

The following are major design considerations for booster chlorination at storage facilities:

- Footprint space for the chlorination storage and feed system facility.
- Access and security for the chlorination facility.
- Injection point for the chlorine.
- Post-treatment chlorine residual monitoring equipment and sampling points.
- Point of diversion of potable water for the chlorine feed system.
- Type of chlorination system: liquid commercial strength (12.5%) hypochlorite or on-site generation of hypochlorite. Gaseous chlorination systems must not be used.

5.9.10.2 Emergency Disinfection

Regardless of whether provisions are installed for booster chlorination, provide for facilities to apply emergency chlorination to each storage cell, to include the following:

- Hatches on top of each storage cell that can be used to introduce chlorine.
- Sample withdrawal points from within the storage cell and on the outlet of the cell to measure chlorine residual.
- Minimum of two valves between the storage cell and the distribution system that can be closed during disinfection.

5.9.11 Removal from Service

The following are key design features for the isolation and removal from service:

- Isolation valves on inlet and outlet lines.
- Piping and valves to provide for bypass of the storage cell.

5.9.11.1 Drain Features

Provide inlet isolation valve, reservoir drain valve, and a drain line to the discharge point. Drain valve must be capable of being throttled as necessary. Locate the drain valve together with the other cell ancillary equipment in a lockable chamber. Drain must be capable of injecting a de-

chlorination chemical with suitable contact time to fully mix if the discharge point is a receiving water body. To the extent practicable, the discharge point for drain water should be the same point used for overflow water discharge.

5.9.11.2 Drain Discharge Points

5.9.12 Standby Power

Consideration should be given to the need for dedicated standby power. In some cases, standby power may be required for some types of projects/facilities for continuous operation.

Alternatives to dedicated standby power may be considered by the reviewing authority with proper justification. At a minimum, a power receptacle to the switchgear is required for the connection of a portable generator. Powered equipment and controls critical for water storage facility operation should be capable of using standby power. For more detail on standby power, see *DSG Chapter 9, Electrical Design*.

A. Sewers

Whenever possible, the point of discharge should be a sanitary or combined sewer because dechlorination of the drain water is not required. If neither a sanitary or combined sewer is available, a storm sewer may be used, but dechlorination is required.

The maximum allowable drain water discharge rate to sewers should be based on the following:

- The hydraulics and sizes of the receiving sewer mains must be checked for any constraints and the maximum allowable dry-weather sewer capacity established.
- The acceptable minimum rate of discharge that meets operational requirements. If the operational minimum exceeds the maximum allowable dry-weather sewer capacity, the local sewer system may need to be modified, such as increase main sizes, re-lay mains to steeper grades, and/or add mains.
- The discharge flow rate design criteria must clearly establish the operational limits for the design flows, e.g. drain operations are limited to dry-weather conditions to preclude sewer surcharging.

B. Open Water Bodies

The discharge of drain water to an open water body such as a lake, pond, stream, or salt water, should be avoided to the extent practicable and only if there are no sewers available or suitable for receiving the discharge. Provisions for dechlorination must be made with guidance from the SPU Water Quality Lab on a project-by-project basis. Some standard methods such as for hydrant testing are available but they are subject to change. To get the most current methods contact the SPU Water Quality Lab.

The rate of discharge to an open water body is highly case-specific. Discharge flow rates to streams will typically be the most limited to preclude scouring and sediment mobilization. It should be assumed that a permit will be necessary for stream discharges, such as a Hydraulic Project Approval (HPA) and/or an NPDES Water Treatment Plant General Permit. Therefore, the permits required must be determined

before design. The specific requirements of the permit are the basis for the maximum allowable design discharge rate.

For more detail on permits, see *DSG Chapter 2, Design for Permitting and Environmental Review*.

5.9.12.2 Washdown Equipment

The following are SPU standards for washdown equipment:

1. The source of water to hose bibs must be potable water from the distribution system.
2. The washdown water piping system must be separated from the distribution system with an approved backflow prevention device.

The following are guidelines for washdown equipment:

- Provide hose bibs or washdown system connections at or near access hatches used for maintenance to each storage cell. Hoses may be permanently stored at or near a hose bib, depending on maintenance and security requirements. However, washdown hoses should never remain permanently attached to the bib to avoid the potential for cross connections. Bibs and hoses should have quick-disconnect fittings for ease of maintenance.
- For larger facilities, provide washdown hose connections in a pattern such that any part of the facility can be washed using a 100-foot-long hose.

5.10 CONSTRUCTION

The section describes design considerations for construction of water system infrastructure.

5.10.1 Requirements for Protecting Water Mains and Appurtenances

Any work on, connecting to, or near existing water mains must monitor and take steps to reduce construction impacts.

5.10.1.1 Conditions Requiring Protection and Protective Measures

Projects that involve roadway construction or repaving, utilities construction, or deep excavations for structures often create conditions that can affect existing water mains (Table 5-11). Pipe with lead joints in older mains is susceptible to leaking and at high risk of failure if exposed to these activities.

Table 5-10
Common Construction Conditions and Protection Measures for Water Mains

Condition	Occurs When and Where	Pipe Protection Measure
Excessive loads	Haul routes for heavy construction equipment crossing over pipes Construction site entrances/exits	Steel plates in roadway Concrete pad Temporary cribbing Bridging

Condition	Occurs When and Where	Pipe Protection Measure
Vibration & Settlement	Paving construction where excavations have reduced the cover over pipes	Pipe relocation
	Dewatering of soils with higher water content around or adjacent to pipes	Temporary pipe supports
	Trench excavations adjacent to water pipes, e.g. excavations for sewer mains or duct banks that result in soil loss	Shoring of adjacent deeper trenches, as applicable
	Tunneling and other large open excavations	Use drilling methods for the installation of shafts / columns instead of vibratory methods to the extent practicable
	Excavations for other utilities below water pipes	Establish clear tolerances for acceptable pipe settlement and provide field monitoring for settlement
	Vibration from construction equipment, e.g. driven piles, sheet piles, or stone columns	
	Excessive loads	
Thrust restraint	Landslides	
	Excavations behind thrust blocks (loss of bearing surface behind the thrust block)	Locate thrust blocks prior to construction
	Excavation and exposure of water pipes that are under pressure (loss of pipe surface friction component of thrust restraint)	Avoid disturbing thrust blocks to extent practicable
		Use temporary thrust blocks or collars
Contamination	Exposed water pipe joints w/in trench excavations that can fill w/ runoff or ground seepage water, particularly if main is depressurized	Avoid exposing pipes that are under pressure
	Exposed water pipe joints within common trench excavations that have an active sewer main, particularly if water main is depressurized	Avoid placement where future excavation may occur behind the thrust block. The clear area behind the thrust block should be determined with the consultation of a geotechnical engineer.

5.10.1.2 Vibration & Settlement

The water system must be protected from vibration and settlement to achieve its full, expected life. Vibration and settlement can cause joints to pull apart and leak or pipes to crack and catastrophically fail. Vibrations and settlement also reduce the flexibility of pipe joints, which can allow ground movement during an earthquake.

A. Monitoring and Protection

When a large project such as building construction, deep excavation, or tunneling takes place near the water system, SPU's main concerns are vibration and settlement of water mains. Any time a large project of this type is planned near an SPU facility, the design engineer should consider requiring settlement monitoring devices be installed on the facility before construction.

Various types of pipe have differing thresholds for both vibration and settlement. Cast iron lead joint pipes have the most stringent protection requirements. Some larger cast iron mains have virtually no allowable settlement.

See **Appendices 5A** and **5B**, respectively, for standard requirements for settlement monitoring of cast iron and ductile iron pipe.

During construction, anytime a design engineer suspects settlement impacts near existing water mains, it should be brought to the attention of the Resident Engineer.

B. Liquefaction Zones

Allowable settlements should also consider liquefaction and landslide zones. Settlement from construction is more critical in liquefaction or environmentally critical areas (ECAs), where settlement has a higher potential. Within these zones, SPU has set strict limits. Only 50% of the settlement/deflection is allowed in liquefaction or ECA zones as compared with other locations.

C. Mitigation of Damaged Water Mains

When vibration monitoring is required, SPU will perform a pre- and post-construction acoustic leak survey of the existing water lines near the construction activities. If damage or leaking increases and the cause is determined to be the construction activities, the RE will send a written request to the contractor to restore damaged or destroyed property to its original condition. The contractor, not the owner or City of Seattle, must pay for and the repair or replacement of the pipe according to City Standard Specifications.

D. SPU Standard Practice

This section has already mentioned several concerns that vibration and settlement brings to the construction of projects near cast iron and ductile iron water mains. The determination of whether or not vibration and settlement monitoring is required is subject to several variables discussed and requirements are not always the same for every construction project. To determine when vibration and settlement monitoring is required, the following criteria have been established as the baseline SPU standard practice. Actual construction methods, equipment used, and the scope and duration of the construction activities may require stricter monitoring requirements or less strict as determined by SPU engineering staff.

1. All construction projects, whether SPU-originated or not, are subject to the following vibration and settlement monitoring criteria: Construction activities greater than 20-feet from water main centerline generally do not require either vibration monitoring (VM) or settlement monitoring (SM). However, if, in the opinion of the resident engineer, project activities appear to be producing significant vibrations at the water main location, the contractor may be required to monitor for vibration.
2. Construction activities ranging between 5 to 20 feet and involving work by heavy equipment that causes vibrations at the water main will likely require VM and possibly SM. SPU Geotechnical Engineer oversight may be required under conditions where the excavation is within the water main zone of influence (see Figure B-1 in [Appendix 5A](#)), or where heavy equipment activities are involved, and at locations with poor soils. In general, SM is triggered by encroaching the zone of influence of the pipe. This is the soil that supports the water main and its bedding and must remain stable. The line of soil support stability is taken as a line descending at a slope of 1 horizontal to 1 vertical from the water main spring line. For example, if the excavation is deep, and it is within the water main zone of influence, then SM is required. If any soil is caving in or if water is

present in the trench, the work must be stopped and the condition must be stabilized, and the construction method or trench conditions may need to be altered.

3. Construction activities within 5-feet of the water main centerline should require VM at a minimum (continuously monitored by equipment). Where the excavation parallels the water main at 5-feet, settlement monitoring should also be required. Where excavations cross water mains, and for parallel trenches, the oversight of an SPU Geotechnical Engineer may be advised.
4. Vibration monitoring requirements may be relaxed by SPU engineering staff if:
 - a. There is no heavy equipment work (e.g. no concrete breaking, no vibratory roller)
 - b. Saw-cut concrete will be pulled away from the water main location by 20-feet or more prior to being broken into pieces.
5. Settlement monitoring requirements may be relaxed by SPU engineering staff if:
 - a. The soil is firm, structurally sound and without water present
 - b. The water main bedding is not uncovered
 - c. The excavation exposes less than 18-feet of water main, and that only one joint maximum is exposed, the risk to water main is lower and therefore the monitoring can be done by the SPU Inspector on site and/or Geotechnical Engineer on site during the work. For example, crossings might fall under this category. If more than 18-feet of water main or more than one joint is exposed, the construction should be stopped until the water main can be temporarily supported within the excavation. See section 5.6.3.6C Temporary Supports during Construction.
 - d. Parallel trenches are shallow (above the zone of influence)
 - e. A non-vibratory roller compaction method is used.
6. This is a set of SPU standard practices. The project should include review by the SPU water asset manager or their engineering or Operations representative because larger pipe diameters and/or water mains that are critical to proper functioning of the over-all water system will require more stringent protection.
7. See specific requirements for VM & SM in **Appendix 5A** for cast iron pipe and in **Appendix 5B** for ductile iron pipe.

5.10.2 Removal and Abandonment of Existing Water Mains and Appurtenances

The following are SPU standards:

1. Where required for water main projects, removal of existing water mains and appurtenances must meet the requirements of Standard Specification 2-02.3(7)B.
2. All ends of abandoned water mains smaller than 12 inches in diameter must be plugged. Pipes 12 inches or larger in diameter must be abandoned and filled in accordance with Standard Specification 2-02.3(5) unless the pipe is to be left in place to be re-purposed for another use such as a utility casing. If Pipe is to be re-purposed, all open ends must be plugged with at least 12 inches of concrete.

3. Water pipes designated on project drawings to be abandoned and filled must be filled with pumpable, flowable cement slurry that completely fills the pipe (Standard Specification 9-05.15).
4. After the record drawings (as-builts) have been incorporated into GIS, the design engineer must check that the abandoned pipe is properly shown.

5.10.2.1 Considerations for Disposal of Hazardous Materials

The design and specifications of projects that remove or abandon water facilities must identify pipes that are known to have or may have hazardous materials. The contractor needs this information to calculate the costs for special handling and disposal. The most commonly found hazardous materials in SPU's water system and considerations for their mitigation or removal are described in Table 5-11.

Table 5-11
Hazardous Materials associated with SPU Water System

Material	Prevalence in System	Mitigation/Removal
Asbestos Cement Pipe	Commonly used in water mains installed in 1940s and 50s. Uncommon now	Avoid removal and abandon in-place where possible. If removal is necessary, containment and filtration requirements must follow OSHA and WISHA
Lead Joints	Almost all joints in older cast iron pipe have lead seals. Most of SPU's distribution system is cast iron w/ lead joints and can be expected to have decades useful service if not physically disturbed	Recycled by crews for other crew work
Coal Tar-Lined and Coated Steel Pipe	SPU has coal tar coatings and or linings in the Cedar River Pipeline System as well as a few other steel pipes	If removed, dispose to a licensed hazardous waste landfill. Working and handling of coal tar materials must follow OSHA and WISHA standards.

5.10.3 Construction, Startup and Acceptance Procedures

The design and specifications for construction activities related to transmission and distribution water mains must address the potential impacts of construction and repair activities on the hydraulic performance and sanitary conditions of the water system. Such activities pose a risk of microbiological contamination of new and existing water mains. Appropriate designs with clear specifications are major elements to achieving hydraulic performance requirements and sanitary conditions after construction or repair of water mains.

See the following Standard Specifications for construction (installation), startup, and acceptance of new and repaired water mains and appurtenances:

Section 7-11	Pipe Installation for Water Mains
Section 7-12	Valves for Water Mains

Section 7-14 Hydrants

For further information on design and operational practices to prevent contamination of water mains, see the Water Foundation publication, *Practices to Prevent Microbiological Contamination of Water Mains*.

5.10.3.1 Connections to City Water Mains

All connections of new or repaired water mains to the SPU water system are made by SPU Water Operations. See Standard Specification 7-11.3(9)A and Standard Plans 300a, 300b, and 300c.

5.10.3.2 Shutdown of Water Mains

Shutdown and isolation of new and existing water mains must be addressed as part of design.

There are three major considerations for the shutdown and isolation of mains:

1. Provide adequate numbers of valves for the isolation of the new or repaired mains to minimize impacts to water service in the distribution grid
2. Work with SPU Water Operations to provide a means to depressurize and dewater the main for a shutdown
3. Consideration of which customers will be out of water and for how long. For customer impacts and service disruptions, see DSG section 5.10.4.

5.10.3.3 Construction and Repair Practices for Sanitary Control

The following section describes construction and repair practice for sanitary control.

A. Pre-installation Materials Storage and Handling

Proper handling and storage practices (Standard Specification 7-11.3(2)) are key elements for achieving sanitary conditions in water mains.

SPU requires a pre-installation taste and odor testing of water pipe (Standard Specification 7-11.2(2)) of non-approved pipe sources. Request a current list from the Water Quality Lab, Moya Joubert (206) 233-2057.

B. Pipe Installation and Repairs

Controlling water and soil from entering pipes is a critical factor for achieving sanitary conditions in water mains. See Standard Specifications for sanitary control practices for water main construction and repairs:

Section 7-11.3(2)A Handling of Pipe – General

Section 7-11.3(5) Cleaning and Assembling Joints

5.10.3.4 Post-Construction or Repair Startup and Acceptance

A. Acceptance

After water main construction or repair, the following requirements must be met before SPU will accept the connection to the water system and place it into service:

- Facility functions meet design requirements and has structural and water tight integrity, as demonstrated by hydrostatic pressure testing
- Sanitary conditions are provided by flushing, disinfection, and verified by water quality testing

B. Hydrostatic Pressure Testing

Water mains and appurtenances, including extensions from existing water mains greater than 18 feet, hydrants, and hydrant runs must meet the requirements of Standard Specification 7-11.3(11).

C. Cleaning and Flushing

After a water main installation has passed the hydrostatic pressure tests, cleaning and flushing must be completed per the requirements of Standard Specification 7-11.3(12)B.

D. Disinfection

The following Standard Specifications address water main disinfection procedures:

Section 7-11.3(12)C	Required Contact Time
Section 7-11.3(12)D	Form of Applied Chlorine
Section 7-11.3(12)E	Chlorine Dosage
Section 7-11.3(12)F	Point of Application for Liquid/Gas Disinfection
Section 7-11.3(12)G	Backflow Prevention Requirement
Section 7-11.3(12)H	Rate of Application
Section 7-11.3(12)K	Disinfection of Connections to Existing Water Systems

E. Water Quality Testing and Criteria

Following chlorine disinfection contacting, samples for bacteriological analysis must be taken per the requirements of Standard Specification 7-11.3(12) A.

All samples must meet the bacteriological criteria. If any sample does not meet the criteria, the installation must be flushed, and re-tested until acceptable bacteriological results are achieved as required by Standard Specification 7-11.3(12)M.

Post-installation taste and odor testing may also be required as described in and Standard Specification 7-11.2(3).

F. Dechlorination

Chlorinated water from the disinfection of water mains must be dechlorinated before discharge.

Depending on discharge location, water drained from pipelines during shutdown must also be dechlorinated.

Typically, SPU uses an ascorbic acid (vitamin C) injection system for dechlorination. The chlorine concentration acceptable for discharge may vary depending upon the type and point of discharge. Discharges to a combined sewer may have some chlorine residual. Discharged water that may enter the environment, either through direct discharge to the ground for infiltration or via a storm drain, should have zero chlorine residual. The design engineer should clearly establish the acceptable points of discharge and chlorine residual criteria in the contract specifications. On most projects, dechlorination of disinfection water is the contractor's responsibility.

5.10.4 Customer Impacts and Service Disruptions

The design engineer or project manager should coordinate with SPU's Communications and Customer Service Branch to determine timelines associated with water main shutdowns.

5.10.4.1 Customer Impacts

All known or potential impacts to customers associated with construction or repair of water system facilities must be identified. Community notification requirements vary depending on the following:

- Length or size of the project area.
- Number of customer services impacted, including anticipated service disruptions.
- Number and type of streets and street intersections in the project area.
- Extent of work outside of public ROW, such as work within temporary or permanent easements.
- Access to project area, including points of access, types of construction vehicles/equipment, and frequency of construction vehicle trips.
- Length of time and schedule constraints of the project.
- Work hours (day, night, weekend) needed to meet the project schedule and/or minimize community impacts.
- Type of environmental impacts to the local community, including noise, dust, mud, and light.

5.10.4.2 Service Disruptions

Service disruptions (water outages) are the impact of most concern to customers. Specific requirements for service disruptions must be established for each project. These requirements can vary depending on type of work, construction constraints, and schedule. Typically, SPU attempts to keep the number of outages for each water service to a maximum of two. The nature of the work and the location of the project may impact SPU's ability to achieve that target for all services.

5.11 OPERATIONS & MAINTENANCE

This section describes O&M elements common to all SPU water infrastructure. See the appropriate sections of this chapter for O&M design issues specific to the infrastructure under design consideration.

5.11.1 Water Easements

An easement gives SPU specific property rights on land that it does not own. These property rights may be temporary or permanent. Permanent rights typically include the right to restrict activities or improvements by the landowner, and gives SPU the right to install, operate, maintain, replace, and have access to SPU utility infrastructure, such as pipes, fire hydrants, or valves. Easements must be project-specific.

Construction easements may differ from standard utility O&M easements because they are temporary. Construction easements may be needed when additional space is needed for staging material and equipment, installing the facility, or temporary access to the construction site.

Table 5-12 lists SPU minimum width requirements for permanent water main easements. This table is a guideline. Engineering judgment and future expansion may require larger easement areas. Easements should be sized to allow for future maintenance and or replacement of the facilities. The size of the easement area for water infrastructure is also subject to the specifics of the site.

Easements are not used in Seattle-owned public Right-of-Ways. Where SPU needs space in public Right-of-Ways governed by other jurisdictions, a franchise permit is obtained.

***Note:** SPU prefers to purchase property and own the land where facilities are installed. However, SPU realizes this is not always possible.*

Table 5-12
SPU Minimum Water Easements

Inside Pipe Diameter or Nominal Pipe Diameter (inches)	Minimum Easement Width (feet)
<8 to 24	20
30 to 92	30

5.12 RESOURCES

Documents

1. Burlington Northern Santa Fe (BNSF) Utility Accommodation Policy, August 21, 1998
2. Burlington Northern Santa Fe (BNSF) Design Guidelines for Industrial Track Projects, October 21, 2001
3. Sound Transit Design Criteria Manual. Contact Joe Herold, joseph.herold@seattle.gov or (206) 386-9857
4. American Water Works Association (AWWA) Design Manuals for Water Supply Practices
5. American Water Works Association (AWWA) Pipe Materials Selection Manual
6. American Water Works Association (AWWA) Potential Techniques for the Assessment of Joints in Water Distribution Systems
7. American Water Works Association (AWWA) Maintaining Water Quality in Finished Water Storage Facilities
8. American Welding Society (AWS): D1.1 Structural Welding Code, Section 3; Workmanship
9. Washington Administrative Code (WAC); Chapter 246-290, Cross-Connection Control Public Water Supplies
10. Washington State Department of Health; Division of Drinking Water; Water System Design Manual
11. Washington State Department of Health; Pipeline Separation Design and Installation Reference Design Guide
12. Seattle Parks Department; agreement on multi-use reservoir sites. Contact Stephanie Murphy, Stephanie.Murphy@seattle.gov or (206) 386-9778
13. Seattle Public Utilities; Water System Plan – 2013. Contact Joan Kersnar, joan.kersnar@seattle.gov or (206) 684-0839
14. Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal. Najafi, Mohammad, PhD, PE. WEF Press, 2004

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-3

Design Standards and Guidelines - Plan Review

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Chapter 18 DEVELOPMENT SERVICES

This chapter of the Design Standards and Guidelines (DSG) describes the plan review function at Seattle Public Utilities (SPU) Development Services Office (DSO). Plan review at the DSO covers a wide range of activities related to the review of plans for private development, government agencies and city capital improvement program (CIP) projects. The primary purpose for this chapter is to act as a resource for plan reviewers within DSO and engineers from other SPU departments.

18.1 KEY TERMS

The abbreviations and definitions given here follow either common American usage or regulatory guidance.

18.1.1 Abbreviations

Abbreviation	Term
CCTV	Closed Circuit Television
CIP	Capital Improvement Program
CMD	Construction Management Division
COS	City of Seattle
DG	Design Guidance
DR	Director's Rule
DSO	Development Services Office
DSS	Development Service System
DWW	Drainage and Waste Water
ECA	Environmentally Critical Area
ETSD	Engineering and Technical Services Division
FOMS	Field Operations Mapping System
GIS	Geographic Information System
GSI	Green Stormwater Infrastructure
HRIS	Human Resources Information System
HWT	Hansen Web Tools
IT	Information Technology
KC	King County
KPI	Key Performance Indicator
LOB	Line of Business
MH	Maintenance Hole
MOA	Memorandum of Agreement
MUP	Master Use Permit
PAR	Preliminary Assessment Report

Abbreviation	Term
PAT	Preliminary Assessment Tool
PDEB	Project Delivery and Engineering Branch
PMD	Project Management Division
PRD	Plan Review Database
PSS	Planning and System Support
RPS	Real Property Services
RSSC	Registered Side Sewer Contractor
SDCI	Seattle Department of Construction and Inspections
SDOT	Seattle Department of Transportation
SIP	Street Improvement Permit
SMC	Seattle Municipal Code
SMT	Seattle Municipal Tower
SPU	Seattle Public Utilities
WPPM	Water Planning and Program Management
WAA	Water Availability Approval
WAC	Water Availability Certificate
WAI	Water Availability Inquiry
WOSM	Water Operations and System Maintenance

18.2 GENERAL INFORMATION

This section describes the authority for and general organization of the plan review function within SPU.

18.2.1 Authority

For the review of projects plans, SPU relies on authority granted by the Seattle Municipal Code (SMC) and various Directors' Rules (DR). SPU has a memorandum of agreement (MOA) with the Seattle Department of Construction and Inspections (SDCI) and the Seattle Department of Transportation (SDOT) granting those departments authority to review projects on behalf of SPU through development permits and public works contracts. SPU documents roles, responsibilities and financial agreements with SDOT and SDCI through MOAs.

The sections of the SMC, which authorize SPU's role in plan review, are described in SPU client assistance memos (CAM). These CAMs are shown in Table 18-8.

The SPU plan reviewer staff review plans to ensure that the SMC requirements for Drainage and Wastewater and Water Lines of Business (LOB) are satisfied in project design. SPU reviews plans to ensure:

- Protection of SPU's infrastructure from adverse construction impacts.
- Preservation of ability to make future improvements.
- Assurance that projects by private developers, other City of Seattle departments, and other agencies comply with the Stormwater code requirements and design standards.

18.2.2 Organization

SPU collaborates with other city departments and government agencies to protect City of Seattle public infrastructure. The DSO relies on SDCI, SDOT, or other municipalities or agencies to identify and refer to SPU projects that could affect SPU facilities. SPU interests include protecting and managing the capacity and operability of its infrastructure. SDCI and SDOT (via MOAs) act on SPU's behalf to protect SPU interests on private property and in the ROW.

Other SPU departments are also involved and coordinate with DSO to protect SPU property, infrastructure, and related interests. Refer to Table 18-1. The DSO plan coordinator routes plans to these other groups if specific triggers are attained or specific questions arise. Additionally, these SPU groups receive plans to review from other City of Seattle departments.

Table 18-1
SPU Sections Involved with Plan Review

Organization	Involvement
SPU Development Services Office (DSO)	Reviews all water, drainage, and wastewater projects, utility and street improvement permits for technical standards and code compliance. Provides guidance for SPU capital improvement projects regarding compliance with the Stormwater Code. Approves new water main extensions, designs and manages water main extension projects, issues water availability certificates, manages approval and sale of water service connections, reviews drawings for water services, and manages installation of water service connection up to the first billing cycle.
SPU Engineering and Technical Services Division (ETSD)	Designs projects per SPU and City of Seattle technical standards and codes. Reviews plans for major interagency projects for compliance with SPU and City of Seattle technical standards and codes.
SPU Construction Management Division (CMD)	Reviews plans to assure compliance with city standards, constructability and manages inspection of projects during construction.
SPU Materials Lab	Reviews plans to assure compliance with city construction product or standard specification.
SPU Real Property	Reviews plans that affect SPU property or easements to protect interests. Obtains easements and /or consent decrees when SPU facilities are on private property. Coordinates right of way issues with jurisdictions in which SPU facilities are located. Coordinates the review and approval of street vacations with SDOT.
SPU Customer Service Division	Acts as main liaison between SPU ratepayers and the other SPU divisions. The division also manages billing and responds to complaints and request for information.
SPU Solid Waste Division	Reviews plans to assure that new construction allows for safe access to solid waste containers by property owners, the public and waste disposal employees and vehicles.
SPU Survey	Reviews plans for work in the ROW to protect City right-of-way and survey monuments. SPU Survey may also conduct or review surveys for SPU or other City projects.

18.3 TYPES OF PLAN REVIEW

The SPU DSO performs four types of plan review: Private Development, SPU CIP projects, other city departments CIP projects, and Franchise Utility projects. The degree of SPU involvement may vary depending on type of permit and project details.

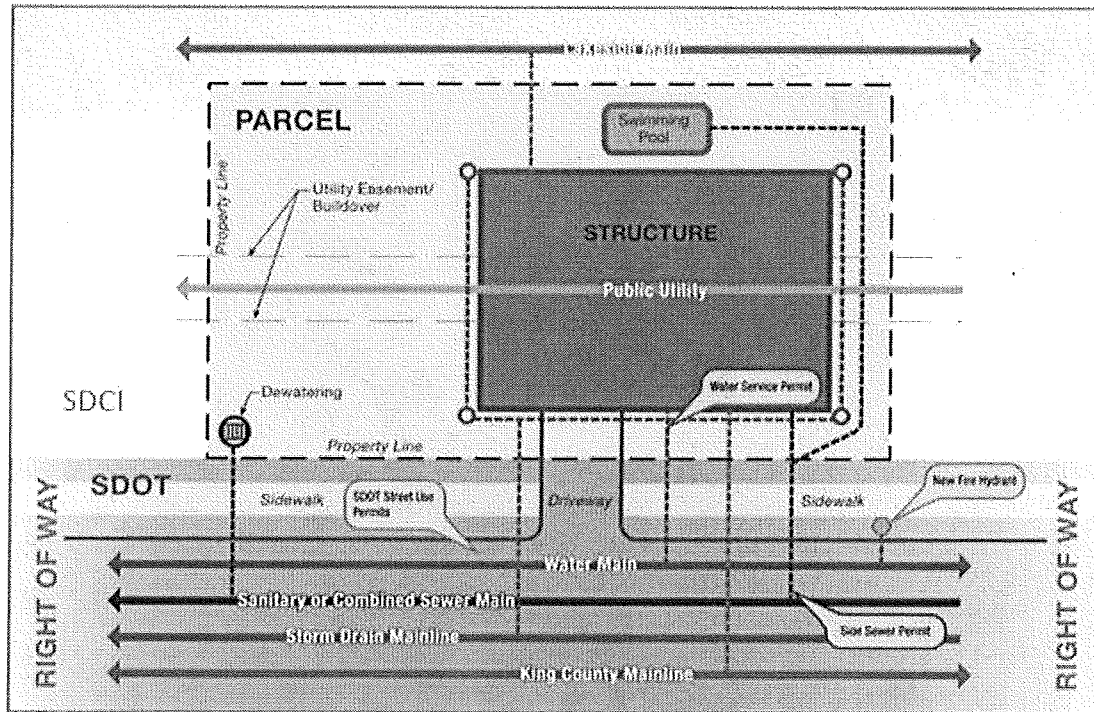
18.3.1 Private Development Projects

Private development refers to projects, which, are constructed by private parties and modify, build, or affect public water, Stormwater, wastewater, or solid waste systems. The SMC regulates private development and requires development permits for most private development. Examples of private development include a new commercial building, subdivision of property, or redevelopment of a block.

City of Seattle development permitting is organized into two primary categories: Private Property and Right-of-Way (refer to Figure 18-1).

- **Private Property.** This development or redevelopment is for a private property owned by either a private party or a public agency. SDCI manages permitting for all work within a parcel through the Master Use and Construction permits. The plans are reviewed, approved, and inspected through the SDCI permit process. Staff in SDCI, SCL, SDOT perform preliminary information about requirements for private development on private property, and any associated improvements in the ROW, through the SDCI-managed Preliminary Application Report (PAR) process, see below.
- **Right-of-Way (ROW).** The development or redevelopment is within the public ROW. SDOT manages ROW permitting through its Street Improvement Permit (SIP) process. The review for Infrastructure impacts is managed by SDOT; however, SPU DSO staff have an active role in the design guidance and formal review (30%, 60%, and 90 %) design permit phases, as well as preliminary design guidance. As shown on Figure 18-1, some permits may cross boundaries. For example, a side sewer permit (a type of construction permit) is issued by SDCI, although part of the permitted work occurs in the ROW. Similarly, permitting issues may cross boundaries because drainage or wastewater discharges from developed parcels can affect adjacent wetlands or SPU infrastructure.

Figure 18-1
Development Permit Boundaries for Plan Review



18.4 SDCI PERMITS

18.4.1 Preliminary Assessment

SDCI administers Preliminary Assessment Process, (PAR), which provides private developer applicants, city departments, public agencies, and local governments with a general set of requirements for their project. The PAR review is prior to the Master Use Permit (MUP) application intake (or building permit application). The PAR report is used to inform developers of requirements that could affect their project. Each city department is required to input information into an electronic tool called the Preliminary Assessment Tool (PAT).

18.4.2 Master Use Permit Review

A Master Use Permit (MUP) is a land use permit that integrates the process, procedures, and review of all non-appealable and appealable land use decisions made by SDCI. This permit is issued before the detailed architectural and engineering plans are developed and submitted with the building permit application. SDCI staff review development proposals for compliance with land-use regulations and SMC. SPU plan reviewers can attend SDCI pre-submittal conferences for MUPs by requesting invitation to the meeting through the PAT or the applicant can request SPU attendance.

18.4.3 Building Permit Review

SDCI issues *building permits*, which are required for most construction in Seattle. SDCI staff (land use planners, plans examiners, geotechnical engineers, and drainage review staff) review private development proposals for compliance with land use, building, Environmentally Critical Areas (ECA), grading, side sewer, and Stormwater codes.

DSO plan reviewers have no direct role in the review of building permits. Their most common role is reviewing and commenting on PARs through SDCI permit process, consulting with SDCI on atypical or complex projects (pursuant to MOA No. 16-124-A Attachment D – Triggers for SDCI Drainage Review and Side Sewer Review Coordination with SPU), and issuing WACs.

18.4.4 Preliminary Assessment Review

DSO plan reviewers follow these steps to review *preliminary assessments*:

1. Access PAT through Hansen Web Tools or Accela after mid-2017.
2. If a PAR(s) has been completed for a project, the project number is shown in red on the right hand side of the screen. Be sure to check the requirements for the previous project before proceeding with the current PAR.
3. Once the SPU review is completed, select “Complete” button to route the project to SDCI Permit staff. SDCI staff will post the completed PAR online and email a copy to the applicant.
4. Use the “Route Back” button as necessary when information in a previous queue requires to be revised. Occasionally, it may be best to contact the reviewer outside of the PAT via email or telephone. If an initial SDCI build-over or main extension requirement is overturned by SPU, then the SPU reviewer must enter a comment in the internal comment field and route the project back to the SDCI drainage review queue.
5. For the Notes & Other Requirements sections, enter “Notes” in the type field for internal comments, which are not to be shared with the public. Enter “Requirement” in the type field for comments directed externally for the applicant.

Table 18-2
Information Included in the Preliminary Assessment Tool (PAT)

Utility	Information to be provided in the Preliminary Assessment Tool
Water	The PAT automatically triggers a WAC review. Information provided by a WAC consists of - Location of standard water main, size and # of existing water services, service pressure, and whether the new water main or upgrade of existing main is required.
Drainage and Wastewater (DWW)	Verify the following information input by SDCI Drainage: • Locations of existing public infrastructure (sanitary sewer, storm drain, or combined sewer) and pipe sizes. • Waive or concur if a main extension is required. • Review whether SDCI has stipulated build-over and confirm if the requirement is valid. • Other additional areas of investigation: ○ If more than one possible connection point, the reviewer may suggest preferred pipe and location of connection. ○ Potential capacity issues.

18.4.4.1 Preliminary Assessment Performance Measures

The SPU service level agreement is to complete the Preliminary Assessment review within 48 hours of receipt from SDOT. If route backs are required, then an additional 48-hour window may be allowed once the project enters SPU's queue a second time.

18.4.5 Side Sewer Permit

SDCI issues side sewer permits, which include all the work associated with the installation of both sanitary, drainage, and groundwater point of discharge. For new construction projects, these permits are processed after the building permit has been approved and construction is underway. Side sewer permits for repairs or additions/alteration unrelated to new construction may be issued independently of a building permit. If work is proposed in the ROW, the side sewer permit must be issued to a Registered Side Sewer Contractor (RSSC). Anyone can apply for a side sewer permit if work is solely on private property.

SPU has an MOA with SDCI to review side sewer permit applications on SPU's behalf, and to inspect the permitted work. As-built (record drawings) are collected by the SDCI inspector, scanned, and sent to SPU's GIS team for inclusion in GIS. SPU is not typically involved in the side sewer permitting process. SPU reviews and confirms the point of discharge during the preliminary assessment. SDCI consults with SPU in situations where SPU expertise is required. SPU has created a trigger list to provide guidance to SDCI on what issues require coordination with SPU. This triggers list is part of the SDCI-SPU MOA No. 16-124-A Attachment D – Triggers for SDCI Drainage Review and Side Sewer Review Coordination with SPU).

18.4.6 Side Sewer Connections to DWW Main Infrastructure

Side sewer permits include the connections made to SPU-owned main infrastructure. SPU crews typically perform the core tap to the main. The side sewer from the SPU-owned tee or wye at the main is installed by an RSSC and inspected by SDCI site inspectors. SDCI drainage reviewers approve standard core tap connections, but coordinates with SPU for any non-standard connections. For more information, refer to Core Tap Procedures for Storm and Sewer Mains.

In addition, requests will come to the DSO from SPU's core tap crew when they are in the field and encounter unexpected conditions or a non-standard core tap, which may not be approved.

18.4.6.1 Non-Standard Connections

A. General

Non-standard connections are subject to additional review by SPU and should not be approved by SDCI or SPU field staff. SPU acknowledges that this can be inconvenient and urges all permit holders to do advance planning, including potholing, when the service lateral may be in conflict with other utilities. In addition, SPU assumes that lateral pipe is laid starting downstream at the tee. Upstream pipe laid out of sequence is not a reason to allow a non-standard connection.

Note that a non-standard connection may result in additional requirements or conditions for permitting the upstream lateral pipe.

B. After Excavation Requests

Requests for a non-standard connection made after excavation is evaluated by following the non-standard connections process described below and, if approved, an amended side sewer permit is issued. Contractors in this situation should:

1. Take all necessary measurements and plate the excavation to allow traffic restoration.
2. Cancel any scheduled core tap.
3. Notify SDCI and SDOT inspectors of the delay.
4. Draw a plan, profile, and details for the proposed solution.
5. Submit drawings to SDCI, requesting an amended permit, following the non-standard connections process.

C. Non-Standard Connections Process

The permit holder must submit plan, profile, and details to describe the proposed non-standard connection to the SDCI Drainage and Sewer Review Desk: (206) 684-5362 or sidesewerinfo@seattle.gov. A short narrative explaining the reasoning for the request may also be helpful, but is not required. SDCI will coordinate with SPU for approval or disapproval of the request. Assume five business days for review. If the request for a non-standard connection is approved, SDCI issues a side sewer permit, or an amended side sewer permit, documenting the allowable connection. The permit holder can then proceed to scheduling.

18.4.7 Side Sewer Permit for Temporary Discharge

SDCI also issues *side sewer permits for temporary discharge* (SSPTD) for temporary construction dewatering. Refer to SDCI [TIP 506](#). The review for this permit occurs during building permit review, as part of review for Stormwater Code Compliance. The review of the SSPTD includes:

- Confirmation that the temporary dewatering is discharged to the approved point of discharge (PSD, PSS, or PS.)
- Review of the temporary dewatering plan.
- Ensuring that the proposed point of discharge is allowed (i.e. the connection is to private infrastructure on private property and to the appropriate system).
- Review that proposed discharge rate is within SPU's guidelines.
- Coordination with King County Industrial Waste Section (KCIW) for their discharge authorization if discharge is connected to the sanitary or combined sewer systems.

SDCI consults with SPU DSO when the established criteria cannot be met. The DSO plan reviewer must balance SPU's infrastructure needs with the project needs. For guidance, see **Appendix 18B**. If the proposed discharge rates are higher than the standard maximum rate allowed, the DSO plan reviewer determines if risks to the infrastructure are within an acceptable range.

When these sorts of temporary discharges are proposed to the sanitary or combined sewer system, the project requires approval from KCIW. In these cases, the SPU plan reviewer communicates the allowed discharge flow rate and any other SPU conditions to the project contact and the KCIW staff, in order to have SPU conditions written into the KCIW permit.

Once SPU and KCIW are satisfied, the SPU plan reviewer informs the project contact and the SDCI drainage reviewer that the SSPTD can be issued.

18.4.8 DWW Determination Meetings

An applicant can request a determination review of a DWW main extension by submitting a Drainage & Wastewater Main Extension Determination Review Request to spu_dso@seattle.gov. The requests follow a process pursuant to and described in Director's Rule (DR) ENG-430.1 and ENG-430.2.

18.4.9 Latecomer Agreement

A *latecomer agreement* provides developers an opportunity to recover a portion of the costs of installing the new utility facilities. This means that a neighboring property that benefits from the utility installation by connecting to it will have to pay its portion of the installation costs of the utility. This neighboring property is a benefitting parcel. In this way, the *first-in* developer does not subsidize these benefitting parcels, which connect to the utility in the next 20 years.

The latecomer agreement is a means to be more equitable to the first-in developer and includes an equitable cost structure for any benefitting parcel that connects to the new utility improvements. While at first it may seem that this is an extra cost to the benefitting parcel, it is a cost sharing mechanism to build the utility infrastructure to which the parcel connects—and the latecomer payment may be affordable than building the infrastructure from scratch.

In 2013, Washington State Legislature passed a law requiring all municipalities to offer utility latecomer agreements to developments that were required to install utility facilities as a condition of development. The City's authority to administer latecomer agreements comes from the Revised Code of Washington, the Seattle Municipal Code, and is detailed in the Director's Rule.

18.5 WATER AVAILABILITY REVIEW

There are two ways to receive approval for water availability, through a *water availability approval (WAA)* and a *water availability certificate (WAC)*.

18.5.1 Water Availability Approval (WAA)

The *water availability approval (WAA)* allows a developer to obtain a building permit from SDCI for new development without obtaining a WAC from SPU. SPU has an MOA with SDCI that allows SDCI to issue a WAA in lieu of a WAC in certain cases. For projects with existing water services, conditions 1-6 below must be met, and for projects without existing water services, conditions 2-7 below must be met. If project conditions change, SDCI's water availability approval is rescinded and an SPU WAC is required.

1. There is an existing water service of either $\frac{3}{4}$ inch or 1 inch in size serving this property. No change to the existing water service (size, type, and location) and no additional water service has been approved.
2. This property will remain a single development site for this project.

3. Only one single-family residence (SFR) is to be located on this property.
4. The SFR is three stories or less in height.
5. The nearest fire hydrant is connected to a 6-inch or larger main and the distance to the farthest corner of the structure does not exceed 600 feet, measured along the parcel or street frontages.
6. The applicant will not be installing a fire sprinkler system, a boiler, a fountain, or an irrigation system.
7. There is an existing 8-inch or 6-inch water main in the street abutting the property (can be any material).

18.5.2 Water Availability Certificate (WAC)

DSO confirms if there is adequate domestic water flow and pressure for a new development by approving a *water availability certificate (WAC)*. The WAC reviewer performs analysis and applies SPU water policy in determining the need for any water system improvements. The WAC reviewer estimates fire flow in determining requirements, but this is subject to confirmation by the Seattle Fire Department. Under most circumstances, the DSO WAC project lead completes these certificates within seven calendar days. The WAC staff apply the policies and procedures outlined in DSO-WS-04 Policy and DSO-WS-04 Procedure.

18.5.2.1 Water availability requests for projects inside the City of Seattle

For projects within the City of Seattle, a WAC is typically triggered during the Preliminary Assessment process at SDCI. However, a developer can request a WAC at any time by completing a [Request for a Water Availability Certificate \(WAC\)](#) and submitting it to SPUwateravailability@seattle.gov. SDCI requires an approved WAC, as indicated by an approved water review in Hansen Web Tools, before they will issue a building permit for new development.

18.5.2.2 Water availability requests for projects outside the City of Seattle

WACs are also required for areas within SPUs service delivery area but outside of the City of Seattle limits. These areas include Shoreline, Burien, Lake Forest Park, Mercer Island, Renton, Tukwila, and unincorporated King County. Since these areas do not get building permits through SDCIs building permit process, they must request a WAC directly from the DSO via email, mail, or in person.

18.5.3 WAC Determination Meetings

An applicant can request a determination review of a water main extension by submitting a [water main extension determination review request](#) to SPUwateravailability@seattle.gov. The requests follow a process pursuant to ENG-430.1 and ENG-430.2.

18.5.4 Latecomer Agreements

Latecomer agreements are also applicable to water main extensions. Please see above section 18.4.9 for more information.

18.5.5 Build-over Review and/or Re-route Process

SPU may allow a developer to construct a permanent structure over or adjacent to an existing combined, sanitary, or storm main located on private property, or re-route the main, subject to site specific engineering and maintenance requirements. If any or all of the requirements is not be met, SPU reserves the right to reject the proposed build-over. An applicant is not entitled to a build-over or re-route, whether or not the criteria allowing approval of a build-over and/or re-route are met.

Real Property Services (RPS) works with the DSO plan reviewer to determine that the city's rights and facilities are adequately protected. The developer must agree to pay the administrative costs plus excess future costs due to the project's construction. For detailed information on build-over review and/or the reroute process, refer to [Tip 507](#) and the RPS/DSO flow chart for the DWW public main build-over and/or re-route process.

Note: Build-overs are approved only for drainage or wastewater mains. Build-overs should not be approved for water mains.

18.5.5.1 Build-over Process

Refer to [Tip 507](#) and the RPS/DSO flow chart for the DWW public main *build-over* and/or *re-route* process.

18.5.5.2 Build-over Review

SPU build-over review may involve a variety of steps and requirements as follows:

1. Re-routing the sewer around the proposed building in lieu of a build-over is the preferred option. This option only works if there is enough grade to maintain flows and if there will be additional access granted for change in direction vertically and horizontally. This will require any existing easement to be relinquished and a new easement (requiring council action) to be recorded prior to permit issuance. If there is no existing easement, new easement should be provided.
2. Replacing the pipe within the same easement may be proposed. Relinquishing an existing easement and getting a new and wider standard easement is easier to get council approval.
3. A public utility easement is issued for the utility main within private property. The Seattle City Council must approve any easement legislation required prior to issuing the permit for construction.
4. If required, a casing pipe is installed around the sewer/storm main (carrier pipe) and, that the inside diameter of the casing pipe must be larger than the outside diameter of

the bell of the carrier pipe. The casing pipe should be approximately twice the size of the carrier pipe diameter to allow for construction tolerances.

5. The minimum thickness of the steel casing pipe should be ¼ inch. External loading may require thicker and stronger casing, such as with larger buildings or railroad crossings, which should be reviewed by a structural engineer. For simple spread footings, casing should extend at least 5 feet beyond the edge of building foundation 1:1 influence line. For pile foundations, casings may extend to less than 5 feet if needed. Steel casing pipe is preferred, although ductile iron pipe (DIP) may be used in certain circumstances.
6. The carrier pipe must be DIP class 50 minimum restrained joint within the casing pipe. The carrier pipe must match or exceed existing capacity of the original design. For sewers, the velocity flowing full within the pipe should be at least 3 ft. /sec, if possible. In instances where planning determines that upsizing a pipe is needed for either increased sewer loads or drainage basin conveyance, it is best to accomplish this during the build-over, if possible. If not, consider at increasing the casing size to accommodate the future carrier pipe size.
7. Private side sewer connections are not allowed within the casing pipe. Re-route existing connections, preferably downstream of the casing. In instances where there needs to be a side sewer connection through the casing pipe, use of a saddle MH is required.
8. That the casing pipe inside diameter is larger than the outside diameter of the bell of the sewer/storm main. The proposed pipe must be sized to convey the design flows for the entire basin under full build-out for the corresponding zoning.
9. Casing spacers should be used to maintain line and grade of pipe and to prevent floatation. Use stainless steel spacers for longevity. Place at bell ends with 9 feet of maximum spacing.
10. An unobstructed 10 x 20 foot-minimum access area located on both sides of the building is preferred. If that is not feasible, SPU may allow one access area for future trenchless maintenance or repair. Larger diameter pipes may require larger access areas and easement widths.
11. A removable end cap or a 1-foot-deep concrete plug is included in order to seal the space between the casing pipe and the carrier pipe.
12. Additional manholes may be required, as necessary, to improve access. This decision should be made in consultation with the Drainage and Wastewater (DWW) System Maintenance staff.
13. Final as built plans should be filed in the SPU Records Vault.

18.6 SDOT RIGHT-OF-WAY PERMITS

SDOT issues *street use permits*, which regulate the use of the public ROW, including construction of projects. Types of street use permits or activities that may affect SPU infrastructure include street improvement permits, utility permits, shoring and excavation review, and street tree permits.

18.6.1 Street Improvement Permit (SIP)

Street improvement permits are submitted to SDOT for installation of major improvements such as street paving, curbs, and sidewalks. Usually, this permit is common to parcel based development. SPU infrastructure is generally located within the ROW and SIP projects are more likely to affect the infrastructure and to trigger the Stormwater code thresholds. SDOT issues SIP for work as required by the Seattle land use code or the Right of Way Improvement Manual. Sometimes, the work permitted by the SIP could be due to a city department CIP, another agency or a voluntary project. DSO reviews a SIP when Water or DWW infrastructure that SPU will own are constructed, when existing infrastructure is impacted, or if the project must meet any performance standards of the Stormwater code.

The SIP process starts at the design guidance phase (0-30% design), and moves to the formal review phase at 90% design and through project construction. The design guidance (DG) phase usually consists of meetings with the project proponent. During the DG meeting staff, from the relevant city departments respond to questions from the design team or provide other information. During the formal review process, paper or electronic plans are submitted to SDOT and SDOT distributes the plans to other city departments, including SPU.

The SIP plans are reviewed for:

1. Compliance with the Stormwater Code Flow Control.
2. Protection of SPU infrastructure. Review is done to identify immediate and long-term risks from construction and operation of the proposed projects. The risks could be due to proximity of proposed construction to SPU infrastructure, parallel deep excavations and excavations over or under water mains or DWW pipes, construction methods, concrete pavement removal over, or adjacent to cast iron water mains, soil nails, sheet piles, and tie-backs intersecting DWW or water pipes and vibration and settlement of pipes due to construction activities.
3. Compliance with City of Seattle standards for SPU utility construction or approval of non-standard construction.
4. Drainage collection and conveyance and conformance with CAM 1180.

The listed impacts could require mitigation by the project owner, in the form of utility protection plans, monitoring of construction by SPU staff, and vibration and settlement monitoring. The review engineer should refer to the resources listed below in order to review the plans uniformly and efficiently and to establish the level of protection:

1. The Plan Review Checklist – DSG **Appendix 18A**
2. Settlement Monitoring for Cast Iron Pipes – DSG **Appendix 5B**
3. Settlement Monitoring for Ductile Iron Pipes – DSG **Appendix 5C**
4. Vibration Monitoring – *DSG Chapter 5, Water Infrastructure*, section 5.10.1.2
5. CAM 1180 - Design Guidelines for Public Storm Drain Facilities
6. Drainage CB and Inlet Notes
7. SPU Mainline Conveyance and Detention Notes
8. Proprietary Stormwater Treatment Notes
9. Rain Garden Notes
10. Infiltrating Bioretention Notes

11. Water Service Notes for Street Improvement Plans
12. Water Main Notes for Street Improvement Plans

18.6.2 Utility Major Permits

SDOT issues *utility major permits (UMP)* for the installation of underground utility mains, overhead wires, and services in the public ROW. They include public utilities such as electric power, water, sewer, and drainage mains; franchise utilities such as communications, gas, and steam; and privately owned facilities such as oil pipelines. UMPs are reviewed to protect SPU infrastructure. Review is done to identify short and long-term risks from construction of proposed projects, as described in the section above. The risks could be due to proximity of proposed construction to SPU water and DWW infrastructure, deep excavations, construction methods, concrete pavement removal over or adjacent to cast iron water mains, soil nails and tiebacks intersecting DWW or water pipes, and vibration and settlement of SPU pipes due to the listed impacts. For details, refer to the resources listed under 18.6.1 (numbered list directly above).

This permit is one that SPU both reviews as an approver and requests from SDOT as an applicant. Many SPU projects need to obtain this permit. See *DSG Chapter 2, Design for Permitting and Environmental Review*.

SDOT distributes the UMP applications to SPU and other stakeholders. After logging the project into the Plan Review Database and distribution to a DSO engineer, the DSO engineer reviews the plan to check for impacts to SPU infrastructure. Comments are transmitted to SDOT, using a standard SDOT SIP Comment form. Simple projects usually require one review, while complex projects may require several reviews. Refer to *DSG Chapter 2, Design for Permitting and Environmental Review*.

18.6.3 Shoring and Excavation Review

Shoring is a means of supporting the earth in a trench or vertical cut for construction or other activity. There are many types of shoring techniques for earth reinforcement or support.

The shoring review is one of the review functions for SDCl. In order to become more customer friendly, SDCl and SDOT combined the shoring review as part of the building permit review process, to allow for a one-stop permit. The shoring review begins at SDCl. At the point of intake, the intake reviewer assigns all necessary review locations for a particular project. *Street use shoring* review is initiated for any proposed excavation that would be greater than 3 feet deep immediately adjacent to any given public right-of-way.

SPU may review the shoring plans if the construction is likely to impact SPU utilities, but typically, SDOT represents SPU in this review function. Projects that have deep excavations, soil nails, and tiebacks and sheet piles may trigger settlement monitoring for water mains and also pre and post CCTV for sewer and drainage pipes. Applicants must complete and submit the *Request to Enter a Maintenance Hole* form before conducting any drilling, grouting, or concrete construction that may affect SPU pipes.

SPU has established a protocol for accessing DWW pipes for the purpose of CCTV and cleaning. The protocol is described in Notes attached as **Appendix 18D**. The notes should be included in

the drawings for projects that have soil nails or tieback systems passing over or under DWW pipes.

18.6.4 Stormwater Code (SWC) Compliance

Property owners are responsible for properly conveying all stormwater, groundwater, and wastewater to an approved discharge location. Detention, treatment, or on-site stormwater management requirements may be imposed.

In the City of Seattle, all proposed development is checked for its impact to the existing drainage and wastewater infrastructure. A master use, building, or street use permit will not be issued until all concerns regarding drainage and wastewater have been addressed. Infrastructure improvements may be required as a condition of the permit when existing infrastructure is unavailable or inappropriate.

DSO engineers use the stormwater code (SWC) to review for stormwater code compliance for public and private development or redevelopment projects. There are 13 minimum requirements for all projects, (SMC 22.805.020). Of these, a reviewer most often encounters requirements to maintain natural drainage patterns, amend soils, implement GSI, protect wetlands, ensure capacity, and comply with the side sewer code. Two additional minimum requirements (flow control and water quality) vary depending on project type and where the site ultimately drains. For assistance in interpreting the SWC, refer to **Appendix 18C – ROW Stormwater Code Flow Chart**.

Additional system requirements may be identified. Drainage and wastewater thresholds for improvements and extensions within the City of Seattle are triggered by code (often a lack of available main in abutting ROW). If there is no sewer or combined main or if the sewer or stormwater drainage main may be under capacity for the improvements, the DSO plan reviewer may need to coordinate with LOB and to determine the following:

1. Possible downstream hydraulic constraints
2. Point of discharge (POD)
3. Evaluation of service alternatives
4. Determination of benefit of new or upgraded main to SPU

The code and other extensive explanatory materials are in the 2016 Stormwater Manual, Volume 1-4 and associated appendices.

18.6.4.1 On-site Stormwater Management

On-site stormwater management using on-site stormwater management BMPs are required under the 2016 Stormwater Code. BMPs limit the negative impacts of stormwater runoff by requiring the implementation of plants, trees, and soils to clean runoff and manage stormwater flows. Bioretention, permeable pavement, and allowable trees and vegetation allow soils to absorb water, slowing flows and filtering out many contaminants. On-site stormwater management can be achieved by either using the (1) on-site performance standard or (2) on-site lists. On-site stormwater management is required for the following thresholds and project types:

1. All roadway projects (SMC 22.805.060) or trail and sidewalk projects (SMC 22.805.040):

- a. $\geq 2,000$ sf new and replaced impervious surface, or
 - b. $\geq 7,000$ sf total land disturbing activity
- 2. All parcels based projects (SMC 22.805.050) or single-family residential projects (SMC 22.805.030):
 - a. $\geq 1,500$ sf new and replaced impervious surface or $\geq 7,000$ sf total land disturbing activity, or
 - b. For a project on a lot most recently created, adjusted, altered, or otherwise amended by a plat recorded with the King County Recorder on or after January 1, 2016, either ≥ 750 sf new plus replaced hard surface or $\geq 7,000$ sf land disturbing activity

For more information, refer to the **Appendix 18C, Seattle Stormwater Code Flowchart** for projects in the ROW.

18.7 OTHER REVIEWS AND PERMITS

DSO engineers also review plans for other city department CIP projects. For these projects, other city departments are the developers. As with the SPU CIP projects, these reviews have many similarities to private development plan reviews. If development or redevelopment is on private property, then the SDCI MUP and building permit process is applied. If in the ROW, the plans are submitted to SDOT and then routed to DSO. Examples of other city projects include: the construction of a new fire station or a new school with the related infrastructure, a new street with storm or sewer mains, or other DWW infrastructure, bio-retention cells for stormwater code compliance; or a new facility by a city department on its property that has full frontage improvements including new water, sewer, and storm main extension. In particular, SDOT street reconstruction projects can have impacts on SPU infrastructure, especially drainage facilities.

18.7.1 Major Interagency Projects

The SPU DSO receives plans for projects from other city departments, government agencies when SPU infrastructure is impacted. These types of projects are categorized as *major interagency projects*. Major interagency projects (MIP) are reviewed and managed by the Project Delivery and Engineering Branch (PDEB) in the Project Management division. DSO role is to transmit documents to the reviewers, provide advice regarding SWC compliance, and manage the sale and installation of water services.

18.7.2 Water Main Extension Contracts

During the WAC review, after reviewing a building permit application or short plat application, DSO staff may determine that a building or parcel is not adequately served by drinking water infrastructure. SPU may issue water availability certificate listing the water system improvements to be made by the developer. Usually, the improvements consist of constructing a standard water main or upgrading a sub-standard main. In order to construct the main, the applicant is required to submit an executed property owner contract and payment of fees specified in the contract to SPU. The contract is prepared by SPU. The cost of designing and

constructing the main is borne by the applicant. The applicant or developer hires a contractor to construct and commission the water main. After the main is constructed, tested, and approved by SPU, the applicant donates the water main to the city. For the complete process, refer to [Install Water Mains](#).

18.7.3 Plan Review and Approval of Water Main Extension Projects

The process of constructing a water main extension project follows the listed steps:

1. After obtaining an approved WAC, the applicant enters into a Water Main extension contract with SPU and pays all associated fees, hires a licensed civil engineer to design the water main or other water improvement to be installed and owned by SPU.
2. The plans are submitted to SDOT as a SIP application. If the project does not have a SIP component, the plans are submitted as a UMP application.
3. SDOT submits the plans to DSO and other city departments for review. The DSO engineer combines review of the street improvement construction, which impacts SPU infrastructure with the review of the water main.
4. The water main is reviewed to assure compliance with SPU Design Standards. The plans may require several reviews before the final approval.
5. After approval, the Mylar is signed, SDOT issues a permit, and the applicant hires a contractor to construct the project.
6. Construction of the project is inspected by an SPU engineer and an SDOT street use inspector.

For detailed information, refer to the [DSO Website](#), under Water Service.

To review a water main design, the engineer should check the listed items:

1. WAC – To match the designed project with the WAC requirements for location, water main size, material, and length.
2. Standard notes – The notes may be revised to suit project-specific requirements. Refer to 18.6.1.
3. Pipe material – Usually DIP, CL 52, or Mechanical Joint. Restrained joint pipe is required when the pipe slope exceeds 15 degrees; pipe is located in liquefiable soil or in a potential slide area.
4. Valves – As shown or described in the City of Seattle (COS) Standard Plans and located at margins of street intersections where mains intersect a perpendicular extension of the curb or property line.
5. Water services – Existing water services are shown on the plans with comments stating if they will be retained or retired. Size and location of new water services is shown on the plans.
6. Easements – When required for new mains, hydrants or water services, easements should be shown on the plans and described.
7. Cathodic protection – The DSO reviewer consults the Cathodic Protection (CP) group, under ETSD, Engineering System support. The group recommends the appropriate CP for the pipe.

8. COS Standard Plans to confirm that the submitted engineering exhibits include the standard location, for the main, a plan and profile, details for standard cover, connection, and blocking details.

Complete guidelines for designing Water mains are described in the *DSG Chapter 5, Water Infrastructure*.

18.7.4 Water Service Installation Plans

After obtaining an approved WAC, an applicant is required to complete and submit a water service application and agreement form, pay for the cost of the water services and submit plans. For small water services (two inch or less), an applicant submits a sketch showing the desired location of the water service.

For 4-inch and larger water services, an applicant submits a well-prepared, scaled drawings as described in CAM 1202. For complete details, refer to *DSG Chapter 17, Water Services*.

The DSO engineer reviews the plans to confirm that the site has adequate space for the trench and a meter vault and there are no utility conflicts. If the plan meets standards, it is approved and transmitted to Water Operations and System Maintenance (WOSM) for construction. If the submitted information is not adequate, the application is returned to the owner for revisions.

18.8 SURVEY REQUIREMENTS AND MONUMENTS

The City of Seattle survey and monument requirements are described in CAM 1401 – Survey Requirements and CAM 1402 Survey Monument Protection. CAM 1401 describes when a survey is required and general information regarding survey. CAM 1402 describes how to locate and identify a survey monument, the developer's responsibility in verifying and protecting monuments, and how a developer gets approval to disturb a monument. See the CAM website for details.

SDOT Street Use has an agreement with SPU ESTD, which allows ESTD to review the SIP for survey compliance on behalf of Street Use. The plans are submitted directly to the Land Survey Technical Resources group, under ETSD. Through this review, street alignments, rights of way, and horizontal and vertical survey control data for projects are reviewed and verified. Usually, the review checks and verifies the listed survey data:

- Vertical datum
- Horizontal datum
- Review the control for right of way alignments
- Right of way width along project frontage

The survey plan reviewer uses city survey records, city quarter section (engineering) maps, city ordinance records, county records, superior court cause documents, state and county survey control databases, and occasionally field verification to confirm that the submitted plan or base map is a reasonable representation and interpretation of survey control.

The survey reviewer may also be asked to review new plats, short plats and lot boundary adjustments submitted to SDOT. In the case of new plats, geometry, ROW, and control of re-aligned streets are checked, and ties to control outside of the plat are reviewed.

18.9 SOLID WASTE

The SPU Solid Waste Division reviews building permit plans for larger multi-family, commercial and industrial projects to assure the following:

- Garbage trucks have sufficient access to dumpsters.
- Sufficient space is available for solid waste dumpsters.
- Dumpsters can be safely moved from their storage location to the pickup location.

18.10 PLAN REVIEW ROLES AND RESPONSIBILITIES

Plan review at SPU is performed by a team as shown in Table 18-3.

Table 18-3
SPU DSO Plan Review Chart

Position Description	Responsibilities
DSO Service Delivery Manager	Manages DSO Plan Review section, assures KPIs are met, coordinates with other SPU and city departments, and assists to resolve complex issues.
Plan Review Supervisor	Assigns projects for review to engineers, tracks progress, and does QC; helps to resolve complex issues.
Plan Review Coordinator	Organizes and distributes plans for review, compiles comments and transmittals, and provides general support; tracks and reports performance measure data.
Primary Reviewer	Engineering plan review and project management; reviews projects for adherence to SPU DSG, city standards, SMC, and relevant DRs.
Conditional Reviewer	Supports primary reviewer by performing specialized reviews, as necessary for adherence to SPU DSG, city standards, SMC, and relevant DRs.

Other City of Seattle departments and groups within SPU share responsibilities for plan review.

Table 18-4 shows an overview of the role of city departments and SPU groups in plan review.

Table 18-4
Plan Review Roles and Responsibilities

Organization	Group	Role	Responsibilities
SDCI	Multiple	Issue permits	• Issues MUP, building, grading, and side sewer permits. • Review to ensure compliance with stormwater and side sewer codes. • Review to protect SPU interests when issuing permits.

Organization	Group	Role	Responsibilities
SCL	Plan Review Team	Review	- Involve SPU as needed or agreed in the permitting process. - Similar to SPU. - Review plans as needed to assure SCL infrastructure is protected.
SDOT	Street Use Operations	Issue permits; Review	- Administers the Street Use process. - Protect SPU interests when issuing permits. - Protect SDOT interests when reviewing plans. - Involve SPU as needed or agreed in permitting process.
SPU	DSO	Review WACs, Review SIPs and UMP, Manage Water main extension projects, provide Technical expertise for DWW projects Authorize new water service, Manage installation of water services	- Assure WAC is issued before accepting new water service applications; plan review to verify SWC compliance and protection of SPU infrastructure. - Accept plans from developers for water service review.
SPU	DWW or Water LOB	Conditional Review	Review plans as agreed with SPU PMD for projects with complex policy issues.
SPU	Solid Waste	Conditional Review	Review building permit plans to assure safe access to dumpsters for residents and garbage trucks.
SPU	Survey	Conditional Review	- Assure plans reviewed meet city survey standards. - Assure planned projects meet city ROW monumentation and future grade requirements.
SPU	Materials Lab	Conditional Review	Assure appropriate products and materials are used in construction projects involving SPU infrastructure.
SPU	Real Property Services	Conditional Review	- Assure SPU and city property are protected - Assure easements and other legal documents protect City property and interests.
SPU	WOSM	Conditional Review	- Assure proposed projects do not negatively impact Operations' ability to operate or maintain SPU infrastructure. - Verifies that proposed projects are constructible.
King County	Dept. of Natural Resources (Wastewater Treatment Division)	Review	- Protect King County wastewater interests - Review plans for wastewater concerns as requested by SPU; Industrial Waste, Construction, and Real Property are sections where coordination takes place.

18.10.1 Coordination

Coordination with other branches, divisions, and departments is critical to successful projects. Table 18-5 lists examples of when coordination is needed with other SPU groups and SDCI. The list is not exhaustive.

Table 18-5
Plan Review Coordination and Conditional Reviewers

Department/Branch	Issues for Coordination
DWW and WOSM	• Provide support for accessing SPU infrastructure • Safety platforms for deep maintenance holes • Inside drop vs. outside drop for MHs • Access to public facilities in difficult to reach locations • Confirm access locations in drive aisles, roads, & private property with SPU facilities • Bend required in-lines • Backwater valves • Pipe slopes less than or greater than allowable standards • Project with limited overhead or horizontal clearance due to trees, overhead utilities, underground utilities, walls, etc. • Utility infrastructure to be decommissioned • Other unique issue creating non-standard installation • Non-standard location or complex/non-standard work by crews • Connections & maintenance of water quality facilities such as storm filters or wet vaults • Utility conflicts • Proposed trees over/near mainline • Opportunistic replacement of plastic or galvanized water services
Real Property Services	• RPS initiates review for projects requiring an easement or build-over agreement • SPU coordinates with RPS easement issues with a build-over • RPS coordinates with outside jurisdictions and SPU facility's needs
Materials Lab	• Point load on pipes due to proposed adjacent improvements • Use of epoxy for water proofing utilidor • Casing pipe inspections • Pipe bedding/support • Trenchless installations • Mix designs for porous pavements and structural inspections • Review of non-standard products or materials • Soil compaction tests
Water and DWW LOB	• SPU ETSD, DSO, and the LOB have a Roles and Responsibilities RACI table that outlines areas the two branches share responsibilities for projects.
Construction Management	• Casting surveys • Constructability review • Inspection services
SDCI	• SPU DSO and SDCI are revising MOA NO. 16-124-A that outlines areas of coordination; this MOA includes a triggers list that shows SDCI site reviewers what types of project issues require coordination with PMED plan reviews. Coordination includes: ○ Interpretation of the Stormwater code for on-site drainage review ○ Side sewer permitting ○ Main extension requirements ○ Temporary construction discharge ○ Build-over or relocation inspections permitted by SDCI ○ Projects that may have significant impacts on SPU system capacity.
Customer Service	• Managing Customer Billing Services • Resource Conservation • Managing and resolving Key Customer Service issues • Cross Connection Control

Chapter 18 Development Services

Department/Branch	Issues for Coordination
	• Sewer sub-meters
Solid Waste	• Review for truck access to large waste containers.
Survey	• Professional survey issues that are elevated by the Developer

18.11 RESOURCES

This section contains information available to SPU plan reviewers.

18.11.1 Codes and Authority

Table 18-6 describes relevant codes and authority that DSO staff relies on to perform plan review.

Table 18-6
Relevant Codes and Authority for Plan Review Staff

Code	Authority
<u>Side Sewer Code (2010)</u> <u>SMC Chapter 21.16</u>	Regulates construction/use of service drains and side sewers in Seattle.
<u>Stormwater Code(2016)</u> <u>SMC Chapter 22.800</u>	Regulates stormwater, flow control, water quality, temporarily during construction, and permanently after construction.
<u>Water Code (2007)</u> <u>SMC Chapter 21.04</u>	Regulates current and future water demands, ensures high quality drinking water, and establishes rates for purveyors and customers.
<u>King County Code</u> <u>KCC Title 28</u>	Regulations for the disposal of industrial waste into the sewerage system and establishment of fees and rules.

18.11.2 Director's Rules

Table 18-7 describes relevant Director's Rules (DR) for plan review staff. Director's Rules are administratively approved and signed by city department directors. They are legally binding rules that clarify how SMC will be implemented and enforced. Most DRs related to plan review are joint SDCI and SPU Director's Rules, and can be located in Table 18-7 or on SDCI's web site.

Table 18-7
Relevant Director's Rules for Plan Review Staff

DR Number	Description
<u>2011-004</u>	Requirements for Design and Construction of Side Sewers (Drainage and Wastewater Discharges)
<u>2011-005</u>	Side Sewer Code Enforcement
2016 City of Seattle Stormwater Manual	
Vol. 1	Project Minimum Requirements
Vol. 2	Construction Stormwater Control
Vol. 3	Project Stormwater Control
Vol. 4	Source Control
Vol. 5	Enforcement
Appendix A	
DWW-420.1	Yesler Terrace Allowable Stormwater, Groundwater, and Sewer Release Rates to the Combined Sewer System and Infiltration Zones
DWW-430.1	Flow Control Requirements for Projects in Identified Public Combined Sewer Basins

18.11.2.1 Memoranda of Agreement and Understanding

Memoranda of agreement and *memoranda of understanding* are binding documents between a minimum of two parties. Often two or more departments or branches/divisions within a department will have a MOA or MOU.

18.11.3 Client Assistance Memos

Table 18-8 describes relevant *client assistance memos* (CAM) for plan review staff. CAMs are general in nature and aid the public in applying regulations.

Table 18-8
Relevant Client Assistance Memos for Plan Review Staff

Client Assistance Memo	Description
SDCI Tips	
<u>TIP 502</u>	Grading Regulations in Seattle
<u>TIP 503</u>	Side Sewer Permits in Seattle
<u>TIP 504</u>	Side Sewer As-Built Plan Requirements
<u>TIP 506</u>	Side Sewer Permits for Temporary Dewatering on Construction Sites
<u>TIP 507</u>	Build-over and/or Re-route Review and Approval Process
<u>Tip 520</u>	Rainwater Harvesting for Beneficial Use - Green Building CAM
SPU CAMS	
<u>CAM 1101</u>	Drainage and Wastewater: Regulation of Development
<u>CAM 1102</u>	Sewer Sub-meter Program
<u>CAM 1180</u>	Design Guidelines for Public Storm Drain Facilities
<u>CAM 1201</u>	Water Availability Certificate
<u>CAM 1202</u>	Water Service Application
<u>CAM 1301</u>	Solid Waste: Information for Developers
<u>CAM 1302</u>	Building Material Salvage and Recycling
<u>CAM 1401</u>	SPU Survey Requirements
<u>CAM 1402</u>	Survey Monument Protection
SDOT CAMS	
<u>CAM 2200</u>	SDOT Street Improvement Permitting (SIP) Process
<u>CAM 2201</u>	90% Complete Street Improvement Plan Requirements
<u>CAM 2213</u>	60% Street Improvement Plan (SIP) Approval Process
<u>CAM 2214</u>	90% Street Improvement Plan (SIP) Intake Appointment and 90% Complete SIP Acceptance Processes

18.11.3.1 DSO Billing Codes

DSO staff use the listed activity codes to track their time.

Table 18-9
Plan Review Timesheet Codes

Activity Code	Title
N437100	General Support
N437001	SDCI Engineering Support
N437002	Other Plan Review

Activity Code	Title
N437003	Water Availability Certificate
N437004	Latecomer Agreements
N437006	DSO Water Services
N437008	DSO Appeals/Clarifications
N437009	DSO Dewatering
SDOT Projects	
Projects billed to SDOT are charged to one of three activity codes:	
NS09029	Design Guidance
NS09030	Plan Review
NS09031	Inspection

When completing a timesheet, the plan reviewer enters the permit number in the Doc # field and a brief description of work performed in the Comment box on the HRIS timesheet. After each pay period, SPU Finance sends a report that includes this information, and the primary reviewer reviews to ensure that all charges are appropriate before approving. SPU Finance then sends the approved billing to SDOT for processing.

Refer to the plan review billing process map. SPU internal CIP projects with an assigned SPU project manager have activity codes that start with a C (e.g. C305501).

Currently, projects originated from SDCI are billed to N480305 SDCI Engineering Support.

18.11.3.2 Technology

The city uses a variety of software to manage and track plan review. To access these systems, the SPU plan reviewer should contact the appropriate IT department (Table 18-10).

Table 18-10
Technology Tools for Plan Review Staff

Software Name	Description	Owner
ArcMap	Viewing, SPU and city utilities and infrastructure, creating maps, organizing data during plan review, project design, and processing of WACs.	City IT
UtiliView	Viewing, SPU and city utilities and infrastructure, creating maps during plan review, project design, and processing of WACs.	City IT
Hansen Web Tools (HWT)	HWT provides a web-based view of SDCI's Hansen permitting application data, and other permitting application data (e.g.: GIS, EDMS.). HWT also provides additional functionality supporting interdepartmental permitting. This tool allows the reviewer to view project information and details from other city reviewers. Access to this system must be requested from SDCI.	SDCI
Preliminary Assessment Tool (PAT)	PAT is an application within HWT that supports determination of code requirements. It is used by SDCI Land Use, SDCI Site Team, SCL, SDOT and SPU. Access must be requested from SDCI. PAT is used in the preliminary application process by Review Staff to provide early guidance and code requirements for all new private parcel development projects.	SDCI
Plan Review Database (PRD)	PRD is an MS Access database used to track plans, archive comments & decisions for projects reviewed by SPU PDEB. It is used for SDOT Street Use Permit plan review, for other departments. CIP plan review, and for other reviews that occurs in the Plan Review Section. Write access is	SPU

Software Name	Description	Owner
	requested from the Plan Review Supervisor, who then contacts the SPU IT service desk.	
Field Operations Mapping System (FOMS)	FOMS is a tool to graphically see Maximo work orders, O&M truck locations, and work order status and expeditiously gain O&M information. O&M truck locations are real time locations using GPS to locate them. (for more info on FOMS, contact SPU_DSG@Seattle.gov)	
Virtual Vault	Virtual Vault is a desktop tool to access to SPU infrastructure as-built information.	
Maximo	Maximo is a desktop tool that enables access to O&M crew scheduling, work activities, and costs. (for more info on Maximo, contact SPU_DSG@Seattle.gov)	
WAC Tracker	Web application for creating and managing water application certificates.	SPU
DSS	Development services system (DSS) is used to track DSO projects and sales of new development services.	SPU

18.11.3.3 DSO Library and File Storage

The SPU Library is located on SMT 45th floor. The library contains copies of industry standards to which SPU subscribes. It also contains engineering textbooks, city standards, and other technical engineering publications.

Physical copies of plans received by SDOT are stored in the PRD portion of central files on SMT 27th floor while plan review is in progress. At regular intervals, completed projects are packaged and sent for off-site archiving.

18.11.4 Mapping

Table 18-11 lists resources SPU plan reviewers and developers use to obtain property information.

Table 18-11
Resources for Plan Review Staff

Resource Name	Description (if applicable)	Link/Location (if applicable)
General		
SDCI Tip 233	Sources for Property Information	Tip 233
City GIS (Public)	Public Information	City GIS
DSO Research Map	External map to research existing Seattle water, drainage, and sewer infrastructure for new property purchases or development.	DSO Research Map (for more info on the DSO Research Map, contact SPU_DSG@Seattle.gov)
City GIS (Internal Use)	Internal Access Information	ArcView & UtiliView
Microfilm Library	Public Information	Seattle Map Counter Public Resource Center, SMT 20th Floor
City of Seattle Vault	400 Scale Water Maps and limited record water system drawings (as-built) - Limited wastewater and stormwater record drawings (as-built) - Sewer Cards (also available on-line) - Reviewers have access to more accurate detailed information from the internal SPU on-line system	Virtual Vault (for more info on the Virtual Vault, contact SPU_DSG@Seattle.gov) 700 Fifth Avenue SMT 47th Floor Seattle, WA 98104 (206) 684-5132 Hours: 8:00 AM to 4:30 PM, M-F

Resource Name	Description (if applicable)	Link/Location (if applicable)
<u>Tip 107</u>	The Tip includes brief descriptions of records maintained by SDCI along with locations and hours of operations, copy fees, and documents exempt from public disclosure	<u>Tip 107</u>
SDCI Public Records		
Plat Maps	Official document that portrays subdivision boundaries, easements, restrictions, and legal descriptions	KC Dept. of Records & Elections
Water		
Water System Map Book	Public Information	Seattle Map Counter Public Resource Center, SMT 20th Floor
SPU DSO	Public Information, Water and DWV information	Water Service Project Leads (206-684-3333), 700 5 th Avenue, 27 th Floor Seattle, WA 98124-4018
Drainage and Wastewater		
Sewer Cards	Historic mapping information (updated until 2001)	Find Side Sewer Card and Maps City of Seattle Vault, SMT 47 th Floor Sewer and Drainage counter at SDCI
SPU Engineer's Maps		See base maps (for more info on Base Maps, contact SPU_DSG@Seattle.gov)
Sewer & Drainage Infrastructure Map Sheets		Seattle Map Counter Public Resource Center, SMT 22 th floor

If plan reviewer notes a discrepancy on GIS maps or sewer cards, verify using the mapping resources listed above, and then once confirmed that a correction is needed, complete a GIS Change Request form to correct discrepancies.

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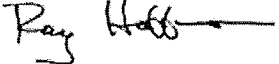
SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-4

Standard, Connection and Administrative Charges – Water

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Title Standard, Connection, and Administrative Charges—Water	Number FIN-210.2	Rev. no. 1
Responsibility Finance Division	Supersedes N/A	Pages 19
SPU Directors's Approval  Ray Hoffman	Effective Date January 1, 2013	

1. **PURPOSE**

To set fees for special recurring and nonrecurring water services provided by Seattle Public Utilities.

2. **DEFINITIONS**

Site-specific costs: For certain services, SPU will determine the cost related to that service based on the site. This site-specific cost will include labor, material, equipment, and any other cost related to that site and that service. Cost will vary between sites.

Time and materials: The cost of a service as calculated by SPU, including labor, equipment, materials, applicable permit fees and taxes, pavement restoration, overhead costs and any similar costs incurred by SPU while performing the service.

Normal hours: Times from Monday through Friday from 7:30 a.m. to 4 p.m., excluding those holidays observed by the City of Seattle.

Extended hours: Times from Monday through Friday from 4 p.m. to 9: p.m., from April through October, excluding those holidays observed by the City of Seattle.

After hours: Times other than normal or extended hours.

3. **NEW WATER INSTALLATIONS AND MISCELLANEOUS SERVICE CHARGES**

3.1 **STANDARD CHARGES FOR INSTALLATION OF NEW SERVICE (EXCLUDING STREET-RESTORATION CHARGES) AND CONNECTION CHARGES**

Domestic Services

Size (Inches)	Installation Fee		Connection Charge
	Residential	Arterial	
¾	\$2,558	\$3,027	\$1,063
1	\$2,645	\$3,113	\$1,807
1 ½	\$5,152	\$5,821	\$3,508
2	\$5,491	\$6,361	\$5,634

Domestic Services (continued)

Size (inches)	Installation Fee		Connection Charge
	<i>Residential</i>	<i>Arterial</i>	
3	Cost *	Cost *	\$11,693
4	Cost *	Cost *	\$18,071
6	Cost *	Cost *	\$35,079

Fire Only Services

Size (inches)	Installation Fee		Connection Charge
	<i>Residential</i>	<i>Arterial</i>	
2	\$7,681	\$10,683	\$2,254
4	Cost *	Cost *	\$7,228
6	Cost *	Cost *	\$14,032
8	Cost *	Cost *	\$22,536

* All services 3 inches and larger will be based on a site-specific cost.

- Plus, as required, Street Restoration charges as stated below.
- Arterial streets include every street, or portion thereof, designated as such in Exhibit 11.18.010 of the Seattle Municipal Code.
- The new service connection charge is based on the Connection Charge Unit Rate of **\$1,063**. For application of connection charges, see SPU's Connection Charge Policy and Procedure. Fire-only services are based on 40 percent of the corresponding new service connection charge. If a domestic service and a fire service are purchased together, contact an SPU Account Executive at 206-684-5800 to determine the applicable connection charge. The connection rate for meters 8 inches and larger is based on the unit rate of **\$1,063**, multiplied by the appropriate meter equivalency factor:
 - 8 inches **\$56,339**
 - 10 inches **\$81,851**
 - 12 inches **\$110,552**
 - 16 inches **\$178,584**
 - 20 inches **\$259,372**
 - 24 inches **\$350,790**
- If new service is being installed with developer water main, see section 4.6.
- Any service request deemed by SPU to be nonstandard will be based on a site-specific cost.

Combination Fire/Domestic Services

Combination fire/domestic services are available in 4-, 6- and 8-inch sizes. These services require approval from the SPU Director or designee.

- All combination fire/domestic services will be based on a site-specific cost.
- Subject to the Connection Charge in section 3.1.

- Plus, as required, Street Restoration charges under section 3.1.

Other New Service Installation Standard Charges

- Street restoration inspection.....**\$367 per job site**
- Street saw cutting.....**\$618 per job site**
- Arterial installations for 2-inch and smaller meters will be charged **\$569** for traffic control if required. For 3-inch and larger meters, costs for traffic control will be considered in the site-specific cost.

All required City, County, and/or State, and other permits and fees are in addition to the standard charges listed above.

Within Seattle City Limits

- Permit Fee**\$146**
- Traffic Control Plan Review.....**\$172 per hour**
- Street Use Inspection Fee (initial and final)**\$172**
- Premium Street Use Inspection (minimum 4 hours)**\$344 per hour**

Unincorporated King County

- Permit Fee**\$200**
- Inspection Fee**\$150 per site**

City of Shoreline

- Permit Fee (one day project)**\$307**
- Inspection Fee (additional days).....**\$ 76.75 per day**

City of Lake Forest Park

- Permit and Inspection Fee (flat fee).....**\$200**

City of Burien

- Permit Usage Fee**\$200**
- Inspection Fee (minimum 2 hours per site).....**\$ 75 per hour**

For ¾-inch and 1-inch services installed in conjunction with new water main construction, if ordered 30 days prior to estimated start of construction: **\$577** reduction from standard charges.

For multiple ¾-inch and 1-inch services installed with a manifold: **\$577** reduction from standard charges for each additional service.

For 2-inch and smaller domestic services installed concurrently with fire services in a common trench: **\$577** reduction from standard charges.

Time and materials, but not less than the applicable standard charge, for all purveyor services, for all services tapped on transmission mains or for special circumstances as determined by the SPU Director or designee.

Contractor Standby Charge when site/contractor not ready as previously scheduled:
\$576 per event

Isolation valve, if required:

- 8-inch **\$6,755**

- 10-inch **\$10,111**
- 12-inch **\$13,689**
- 16-inch site-specific cost
- Isolation valve installation is subject to the Street Restoration charges under section 3.1.

Ring and cover casting, if required:

- For new or existing ¾-inch, 1-inch and all fire service: **\$174** additional
- For new or existing 1½-inch or 2-inch domestic services: **\$728** additional

Automated meter reading equipment, if required by meter installation standards:

- 2 inches or smaller meter **\$257** additional
- 4 inches or larger, single register,
with fire service **\$257** additional
- 4 inches or larger, two register
(domestic or combo) **\$454** additional
- 4 inches or larger, three register,
with fire service **\$649** additional in the same chamber

Service Conversions

All service size conversions will be based on a site-specific cost.

Note: Service conversions are subject to the Connection Charge in section 3.1.

Street Restoration

Street restoration costs are in addition to the above charges and will be assessed based on street paving type and condition. Charges will be based on a jobsite pre-installation inspection and in accordance with the requirements of the Seattle Department of Transportation's (SDOT) Street and Sidewalk Opening and Restoration Director's Rule (5-2009).

If the customer chooses to have street restoration work arranged by SPU, the fee for street restoration will be collected from the customer at the same time the fee for the new water service is collected. If the customer chooses a private contractor to perform the street restoration work, the customer must: (1) obtain SDOT approval of the contractor and the applicable SDOT street restoration permit/street improvement plan permit; and (2) submit the SDOT permit number to SPU at the same time the customer submits the payment to SPU for the new water service.

Street restoration costs for SPU water service work in Washington State Department of Transportation right-of-way, City of Burien, Skyway, City of Shoreline, City of Lake Forest Park and unincorporated King County are based on agreements with these cities or state agencies. Charge will be determined by jobsite pre-installation inspection by SPU and street restoration agreement with these jurisdictions.

3.2 SERVICE SIZE INCREASE

To increase service size of existing 1 ½-inch and smaller service in the same location (within 30 inches of existing service) at customer request, applicable new service installation charge will be made (see section 3.1). No charge for meter removal or retirement will be made. Subject to limitations established by SPU Director or designee.

Exception: To renew and increase ½-inch or ¾-inch steel or plastic service to 1-inch copper service in same location (within 30 inches of existing service) at customer request: **\$242**.

Size-increase request at a location exceeding 30 inches from existing service will also be subject to a new service installation charge (section 3.1) and service retirement charges (section 3.6) for the existing service.

Service size increases are subject to the Connection Charge and Street Restoration charges under section 3.1.

3.3 SERVICE SIZE REDUCTION (WITHIN 30 INCHES OF EXISTING SERVICE)

2 inches and under, when reduced to smaller size: **\$268**

All other sizes: Site-specific cost

Service size decreases are subject to the Street Restoration charges under section 3.1.

3.4 METER TEST AT REQUEST OF CUSTOMER

Charge will be waived if tested meter is found to be over-registering.

Tests conducted at the meter shop:

- Meter shop test of 1 ½ inches and under **\$395**
- Meter shop test of 2-inch meter **\$417**
- 3-inch and larger meter **\$544**

Field testing of 1-inch or smaller meters **\$105**

Field testing retail-service meters
outside Seattle direct-service area **\$643**

3.5 METER REMOVAL

- ¾- inch or 1-inch meter **\$147**
- 1 ½ -inch or 2-inch meter **\$191**
- 3-inch and larger meter **Site Specific Cost**
- Removal of illegal jumper **\$110**

3.6 SERVICE RETIREMENT

Abandonment with or without meter removal. This charge also applies to a customer requested service transfer from one abutting water main to another, not related to new water main construction. No charge for retirements if a new service is installed within 30 inches of the service to be retired.

- 1 inch and smaller **\$1,422**
- 1 ½ inch and 2 inches **\$1,519**
- 3 inches and larger..... **\$5,987**

Additional service retirement charge for second trip due to contractor delay. When contractor needs continuous water service or some other condition requires SPU to return to job site to perform the retirement.

- 1 inch and smaller **\$853**
- 1 ½ and 2 inches **\$911**
- 3 inches and larger **\$3,592**

Service retirements are subject to the Street Restoration charges under section 3.1.

Repaving happens after SPU visits the site. If a contractor repaves before this time additional costs incurred by SPU will be billed at Time and Materials.

3.7 METER RESET

For meter resets following customer-requested or credit related removals:

- ¾-inch meter **\$222**
- 1-inch meter **\$224**
- 1 ½ -inch meter **\$459**
- 2-inch meter **\$563**

Install temporary service jumper:

- 2 inches and smaller: **\$76**

Note: If reduction in size occurs at time of reset, then charge reduction fee only.

3.8 SPECIAL FIELD TRIPS [revised January 1, 2017]

Responding to meter/service shut-off and turn-on requests initiated by the customer:

- Applies to requests initiated by the customer, the customer's contractor, agent or tenant, or by emergency responders acting to protect the customer's premises.
- For all non-credit shut-off or turn-on visits, the ~~((same))~~ charges ~~((apply as for credit related meter turn-ons and shut-offs))~~ are listed in section 3.11.

Investigating on-property loss of water:

- When loss of water is caused by actions taken on-property, the same charges apply as for meter turn-ons and shut-offs listed in section 3.11.
- When investigating leaks on-property and it is found that the City water service line is intact, the same charges apply as for meter turn-ons and shut-offs listed in section 3.11.

Inspection services for re-inspection required because the requesting customer is not ready for inspection by deadline or stated date: **\$210.**

Special meter read:

- For actual readings meters of all sizes ordered in connection with property ownership or occupancy changes **\$100**
- For obstructed meter readings **\$125**
- Adjust buried, obstructed or low meter boxes or valve boxes caused by customer installed landscaping or resurfacing (¾-inch to 2-inch meters) **\$464**

Trim customer-installed vegetation obstructing meter boxes or fire hydrants: **\$157**

Replace customer damaged lock: **\$50**

3.9 STATEMENT OF COMBINED UTILITY ACCOUNT

Customer request for billing system screen-print statement of account activity for each 12-month period: **\$8**

Customer request for formal statement of account activity, for each account number per 12-month period: **\$56**

External utility request for water consumption information to be used for billing the retail services of that utility: **\$2** per account for information covering any period of 12 months or less.

3.10 PROCESS RETURNED CHECK OR DRAFT

Includes checks returned for nonsufficient funds or other reasons which prevent processing: **\$25**

3.11 ~~((CREDIT AND COLLECTION CHARGES))~~ METER SHUT-OFF AND TURN ON AND LATE PAYMENT CHARGE [revised January 1, 2017]

Meter shut-off or turn-on charge, including Fire Services. Charges are for each trip.

Meter size (inches)	Charges		
	Normal Hours	Extended Hours	After Hours
¾ to 2	\$164	\$287	\$537
3 or larger	\$563	\$673	\$782

- ~~This charge may be suspended in special circumstances as determined by the Director of SPU or designee.~~
- ~~No charge for the first trip for a credit related turn-on during SPU normal business hours. Second and subsequent trips are subject to applicable standard charge above.))~~

Late Payment Charge. Past due balances may be subject to a late payment charge that will include one or both of the following charges:

- Collection Notice Charge: **\$12** for active account Urgent or Shutoff Notice, or closed account Final Notice.
- Delinquent Interest Charge: Monthly interest at the legal rate on past due balances.

((Credit field visit: **\$44**))

3.12 DUPLICATE BILL PREPARATION

For all duplicate bills produced at customer request after original bill was produced: **\$7**

3.13 DELAYED FINAL CUSTOMER BILLING

Customer request for final bill when notification is received more than 45 days after final bill date: **\$41**.

3.14 ACQUISITION OF HYDRAULIC FLOW DATA

Where records are available for fire protection grading purposes: No charge.
SPU measures hydrant flow, flushes main, and prepares flow test report: **\$2,002**

Contractor measures hydrant flow with SPU assistance, SPU flushes main and reviews flow test results prepared by contractor: **\$1,048**

Performance of hydraulic analysis and report to determine best alternative to meet or exceed fire flow requirements: Time and materials with **\$2,000** deposit.

Preparation of Hydraulic Modeling Simulation Report, when a flow test is not feasible, during a declared water emergency, or when a calibrated hydraulic model is available: **\$407**

3.15 NON-FIREFIGHTING HYDRANT USE PERMIT

Permit fee: **\$214**

Hydrant meter fee: **\$304** charge for any SPU supplied hydrant equipment and material. All equipment and material must be returned in the same-as-issued condition. In the event of damaged or lost equipment, SPU will assess charges equal to the cost of damaged or lost equipment, including overhead cost.

A hydrant meter is required and commercial water rates are charged. If SPU determines water use will be less than 10 CCF per day, at SPU's discretion, a hydrant meter may not be used and the following rates will apply:

- September 16 to May 15 **\$45** per day
- May 16 to September 15 **\$57** per day

At the discretion of SPU, permits assigned a hydrant meter are subject to the above per day charges for the entire term of the permit if:

- There is any evidence of hydrant meter tampering.
- There is damage to the hydrant meter prohibiting SPU to accurately determine the amount of water used.

The minimum consumption charge for a hydrant meter shall be:

- September 16 to May 15 **\$45** per month
- May 16 to September 15 **\$57** per month

During a declared water emergency, any hydrant permit users allowed to continue their permits will be charged at established surcharge commercial rate, if any.

3.16 HYDRANT RESET

Set hydrant back or move closer to water main, where no re-tapping of main is required: **\$9,045**, plus City or County permitting, plan review or inspection fees.

Plus, as required:

- Street restoration charges under section 3.1.
- Street restoration inspection: **\$367** per job site
- Quick connect adapter: **\$304**

3.17 HYDRANT RELOCATION

Remove existing hydrant and move to new location, new tap on main required: **\$17,413**, plus City or County permitting, plan review or inspection fees.

Plus, as required:

- Street restoration charges under section 3.1.
- Street restoration inspection: **\$367** per job site
- Quick connect adapter: **\$304**

3.18 INSTALL NEW HYDRANT ON EXISTING WATER MAIN

Install new hydrant on existing water main: **\$6,050**, plus City or County permitting, plan review or inspection fees.

Plus, as required:

- Street restoration charges under section 3.1.
- Quick connect adapter: **\$254**

3.19 INSTALL VERTICAL EXTENSION ON EXISTING HYDRANT

Install vertical extension on existing hydrant: **\$2,132**, plus City or County permitting, plan review or inspection fees.

Plus, as required: Street restoration charges under section 3.1.

3.20 CROSS-CONNECTION CONTROL PROGRAM

Charge for mailing reminder letters to customers who do not provide acceptable proof of satisfactory performance test of their backflow preventers within 30 days of receiving original notification, or to customers who have not installed backflow preventers as required: **\$107** for each backflow preventer.

Late assembly test shutoff notice: **\$157**

Shut-off and turn-on: Applicable standard charge for Special Field Trip as specified in section 3.8.

3.21 ACCESS ALONG OR CROSSING TRANSMISSION RIGHT-OF-WAY

Gate opening

- Minimum: **\$175**
- Charge may be in excess of the minimum depending upon the circumstances of opening.

Third-party work on SPU property: Time and materials costs for City employees and equipment stationed to protect City property the pipeline during third-party work on SPU Property shall be charged as per section 5.10.

3.22 ADDITIONAL SERVICES

Relocation of meter and box

Limited to a lateral move of 30 inches, deposit amount to be determined upon order:
Billed at site-specific cost.

Service damage

For repair of damaged curb stop or meter setter, tailrun, etc.: Billed at site-specific cost.

Water main cut and cap

For cut, cap and block of existing water main: Billed at site-specific cost.

Design and/or Install Pressure Reducer

- SPU design, time-and-materials - deposit **\$8,200**
- Installation by SPU, time-and-materials - deposit:
 - 4 inches PR (2 inches Bypass) **\$31,000**
 - 6 inches PR (2 inches Bypass) **\$33,000**
 - 8 inches PR (4 inches Bypass) **\$41,000**
- The deposit amounts listed above are the expected project costs, and do not include the cost of street repair. Street repair costs will be borne by the developer.

Work Outside Normal Business Hours

All work performed outside of SPU normal business hours due to customer request, or due to customer water supply concerns, will be charged at an overtime rate.

SDOT Right-Of-Way

When any work is to be performed in a SDOT right-of-way which necessitates a Letter of Justification: **\$600** deposit required for application to SDOT by SPU.

Installation Plans

Water meter and fire hydrant installation plans may be prepared by SPU at the developer's expense. The cost to prepare the plans depends primarily on the availability of as-built information and the number and complexity of the existing utilities. An advance deposit of **\$360** is required from the customer before design work begins.

4. DEVELOPER PROJECTS

Note: Charges paid more than 12 months in advance of work performed will be recharged at current year's rate.

4.1 WATER MAIN CONNECTION

For cut-in tee connection to charged water mains, SPU furnishes sleeve(s) to connect new tee into existing main. For wet tap connection, SPU furnishes tapping sleeve and tapping valve. Contractor furnishes all other materials, tees, valves, valve boxes and lids, fittings, sleeves, excavation, backfill, compaction and restoration. SPU performs shutdown and draining of existing mains, connection of new main, and restoration of service: **\$5,656** per connection.

- Any service request deemed by SPU to be nonstandard will be based on time and materials.

4.2 WATER QUALITY INSPECTION, SAMPLE COLLECTION AND BACTERIOLOGICAL TESTING

- **\$943** for first 500 feet of water main
- **\$660** for each additional 500 feet thereafter

4.3 DESIGN REVIEW, PLAN APPROVAL, ADMINISTRATION AND ACCEPTANCE OF MAIN

- **\$3,272** per water main project

4.4 CONSTRUCTION INSPECTION

Rate includes travel to and from job site:

- 100 to 300 lineal feet..... **\$8,311**
- 301 to 500 lineal feet..... **\$11,821**
- Less than 100 and over 500 lineal feet require special estimate: time and materials

Time and materials will be charged for re-inspection caused by contractor.

4.5 COMPACTION TESTS

Required when contractor uses native or imported backfill instead of control density fill

- Field in-place density test per ASTM D 2922..... **\$145**
- Maximum dry density per ASTM D 698 **\$190**

4.6 NEW SERVICE INSTALLATION (DEVELOPER)

Standard charges will be reduced for new service installation in conjunction with developer installed water mains. None of the discounts for nondeveloper service installations listed in section 3 apply to the developer fees listed below.

The following conditions must be met:

- Property is within the direct service area of Seattle's water utility
AND EITHER:
- Developer is installing a water main to serve the property
OR
- During peak work load conditions, the Department authorizes the developer to open trench, shore, backfill, and complete all street/sidewalk paving restoration.

Note: If above conditions are not satisfactorily met, developer will pay SPU on a time and materials basis for completion of work.

Charges for new service installations meeting the conditions above are:

Domestic Services

Size (Inches)	Installation Fee	
	<i>Residential</i>	<i>Arterial</i>
¾	\$1,963	\$2,315
1	\$2,049	\$2,402
1 ½	\$4,432	\$4,983
2	\$4,796	\$5,567
3	Cost*	Cost*
4	Cost*	Cost*
6	Cost*	Cost*

* All services 3 inches and larger will be based on a site-specific cost.

Fire Services

Size (Inches)	Installation Fee	
	<i>Residential</i>	<i>Arterial</i>
2	\$6,735	\$9,686
4	Cost*	Cost*
6	Cost*	Cost*
8	Cost*	Cost*

* All services 3 inches and larger will be based on a site-specific cost.

Arterial streets include every street, or portion thereof, designated as such in Exhibit 11.18.010 of the Seattle Municipal Code.

If new service is being installed with developer water main, see section 5.

Any service request deemed by SPU to be nonstandard will be based on a site-specific cost.

Combination Fire/Domestic Services

- Combination fire/domestic services are available in 4-inch, 6-inch and 8-inch sizes. These services require approval from the SPU Director or designee.
- All combination fire/domestic services will be based on a site-specific cost.

Legislation for an easement granted to the City of Seattle for infrastructure to be owned by SPU but installed by a developer, see section 5.6.

5. PROPERTY SERVICES

SPU must charge for any administrative costs it incurs as a result of processing applications or requests for the use of SPU's property, or the purchase of SPU's property or property rights (such as an easement). These costs can be charged in the form of a "Standard Charge" or "Time and Material" as established by section 5.

In addition to administrative costs SPU must receive "Fair Market Value" for any property sold, easements granted, other permanent or temporary property rights granted, or the use of SPU Property. Fair Market Value can include the value of any real and substantive benefit to SPU, such as mutual and offsetting benefits.

Unless otherwise provided by Ordinance, no permit shall be issued that would extend for more than a year. Otherwise, all permits must be revocable.

Due to the variables inherent to real property transactions, administrative costs, legislative costs, and Use Fees established by section 5 may not always accurately apply. In such cases, charges may be adjusted to reflect the actual situation.

Leasehold Excise Tax is required on all permits and leases as required by RCW 82.29A, and RCW 82.29A.130.

All charges established by City of Seattle ordinance or regulations take precedence over all charges established in section 5.

5.1 TIME AND MATERIAL CHARGES

If SPU determines that a standard charge established by section 5 is expected to be inadequate to cover SPU's administration costs arising from any application or request, an estimate of the expected Time and Material cost will be determined by SPU. The applicant or requester shall pay the estimated amount, which shall be deposited in a SPU Guaranteed Deposit Account, and billed periodically. If actual Time and Material costs are less than the deposit, the balance shall be refunded; if the actual costs exceed the deposit, the balance owing will be charged to the applicant.

If mutually agreed between SPU and the applicant or requester, the estimated amount may be paid up-front as payment in full, and no accounting of Time and Materials will be kept.

At SPU's discretion, a deposit will not be required for governmental or public entities such as state, county or municipal governments, or public utilities, provided that such entity has entered into an agreement with SPU to pay accrued charges on a periodic basis.

5.2 STANDARD CHARGES FOR USE PERMIT APPLICATION

The following fees are nonrefundable:

- **\$1,835** is the standard charge for the administrative costs of a permit application, when administration costs are expected to require up to 16 hours of SPU time. Generally, this charge applies for simple utility crossings, linear use, and surface use of SPU property. If more than 16 hours are expected to be required, Time and Material costs may be charged. Simple activities may include electrical, communications cables, gas, or water services that cross over the top of SPU water transmission pipelines.
- **\$450** is the standard charge for the first-time preparation of a Special Short-Term Surface Use Permit. **\$150** will be the standard charge for each renewal of the permit. In addition, the permittee is required to pay the appropriate gate opening fees, the Special Short-term Surface Use Fee as provided in section 5.3, and provide proof of insurance as required by SPU. A single permit may be issued for recurring use up to 30 days per year. This fee schedule generally applies to community or organization events or related parking.
- **\$600** is the standard charge for permittee name change with no change in use. Permit terms, conditions, and use fee, may be updated.

5.3 USE FEES

In addition to the standard charge for Use Permit Application Fee under section 5.2, fees for the use of SPU property for permits and leases to be granted shall be established at "Fair Market Value" unless a specific rate is provided in section 5.3:

Utility Crossings

There is no use fee for utility crossings of SPU fee-owned right of way.

General Surface Use

- There are use fees for surface use of SPU fee-owned property. Typically this use is by adjacent property owners for parking, but can include other uses such as construction staging, job shacks, etc.
- The Annual Use Fee for all for-profit permittees shall be no less than **\$1,000**, even if the estimated "Fair Market Value" for the use of the SPU fee-owned property is less.

Special Short-term Surface Use

\$50 per day. Typically this use is for short term parking for community sponsored and non-profit events that are compatible with utility use, but is not limited to parking.

Linear Use of Property

There are use fees for linear use of SPU fee-owned property. Linear use is typically non-SPU utility installation of surface, underground, or overhead infrastructure. Linear use

fees are currently under review. Until such time as the fees are officially changed, unless established otherwise by an existing permit, the following fees apply.

- **\$500** annual use fee for each conduit or cable, plus 25 cents for each conduit or cable for each linear foot over 1,000 feet. This fee applies to cable, conduit, or wire of no more than 4 inches in diameter. This fee will be determined on a case by case basis for larger sizes or more impactful installations.
- When issuing new permits, there is a **\$250** annual use fee for each hand hole, vault or other above or below ground structure measuring more than 1 ½ feet, but less than 3 feet, in width, height, or depth. The annual use fee for each hand hole, vault or other below or above ground structure measuring over 3 feet in height, width, or depth shall be determined on a case by case basis. An annual use fee may be instituted for each hand hole, vault or other above or below ground structure that is discovered to exist within SPU property but was not reviewed and pre-authorized by SPU.

Utility Use in SPU Tunnels

Use fees are currently under review, and could be changed at any time. Until such time as the fees are officially changed, unless established otherwise by an existing permit, the following annual fees apply.

- **\$966** for each communications related conduit or inner duct under 2 inches diameter.
- **\$1,931** for each communications related conduit between 2 to 3 inches diameter.
- **\$2,896** for each communications related conduit (which can contain inner duct) 3-plus inches diameter up to 48 square inches in cross sectional area of the cable or conduit.
- The annual use fee for non-communications related facilities shall usually be at the same rates as the communication facilities. However, the fee may be determined on a case-by-case basis.
- Any facilities of more than 48-square inches in cross-sectional area may be determined on a case-by-case basis.

5.4 PREPARATION OF LEGISLATION

The following fee is nonrefundable.

\$7,115 is the standard charge for the administrative cost for any legislation required due to the requests or actions of any person or entity, other than SPU. This charge is based on the requirement that the applicant and or requester provide all necessary information, such as: acceptable proof of ownership, signatory authority, and an adequate survey and legal description. If, due to the applicant or requester's actions, SPU staff time significantly exceeds the cost of the standard charge, the applicant and or requester may be charged for additional SPU Time and Material costs.

Legislation is required when SPU buys or sells property, grants or acquires easements or any other property rights, grants permits, rental agreements or leases for more than one (1) year in duration.

Legislation is required for Partial or Full Transfers of Jurisdiction between City Departments.

5.5 REAL PROPERTY REVIEW OF STREET VACATION APPLICATIONS

No charge if SPU infrastructure is not located within the proposed vacation area.

Time and Materials shall be charged to the applicant or requester for SPU costs when either there is SPU infrastructure in the street vacation area, or the street vacation will impact other SPU infrastructure.

All reservations of rights for SPU infrastructure shall be subject to all other applicable costs and fees including, but not limited to legislation costs.

5.6 SURPLUS, SALE OR EXCHANGE OF SPU FEE-OWNED PROPERTY

Time and Materials and Preparation of Legislation costs shall be charged, as per section 5.1, for SPU costs in conjunction with the sale or exchange of SPU property, when initiated by an outside entity. These costs may include, but are not limited to: SPU staff time, title, appraisal, survey, document preparation, closing and recording. If actual costs are less than the deposit, the balance shall be refunded; if the actual costs exceed the deposit, the balance will be charged to the applicant.

Time and Materials and Preparation of Legislation costs generally are not charged when SPU initiates a sale of surplus property.

In addition to these charges, SPU must receive Fair Market Value for its property.

5.7 ENCROACHMENTS

Encroachments are unauthorized use of SPU fee-owned property or easement rights. Types of encroachments and the impact to SPU property rights vary greatly. Therefore, the Time and Material and Use Fees to resolve encroachments shall be determined on a case-by-case basis.

5.8 MINOR PROJECTS AND ACCESS TO SPU PROPERTIES

Gate opening fees according to section 3.21.

\$165 per hour with a one hour minimum charge for entry to SPU facilities when a security specialist is required for access and/or to stay with non SPU personnel while on SPU property.

\$80 to \$125 per hour will be charged (hourly rates will vary) for entry to SPU facilities when SPU personnel are required for access and/or to stay with non SPU personnel while on SPU property. The rate will include overtime when applicable. When overtime is applicable, a minimum of 4 hours overtime will be charged. Travel time will also be charged.

\$125 may be charged if a Site Security Plan provided by SPU Security is required.

6. LABORATORY ANALYSIS [rescinded January 1, 2017; see FIN-220.3]

All laboratory analyses will be conducted at the discretion of the Water Quality Laboratory Manager and on the basis of time availability. Prices reflect the cost for routine analyses with standard reporting and turnaround times. The price for analyses not included in this list will be based on the cost for labor, equipment, material and overhead, as determined by the Water Quality Laboratory Manager. If available and mutually agreeable, analyses may be available on a call-out basis at double the charges listed.

6.1 BACTERIOLOGICAL ANALYSIS PER ANALYSIS

Total Coliform (MF)	\$27
Total Coliform (MPN)	\$23
Total Coliform/E. Coli (MMO/MUG; P/A)	\$18
Coliform verification; including	
Fecal Coliform/E. Coli (EC/MUG)*	\$28
Fecal Coliform (MF)	\$27
Fecal Strep (MF)	\$23
Enteric culture identification (API)	\$109
Heterotropic plate count	\$29
Pseudomonas (MF)	\$27
Biolog	\$159
Sample prep for non-drinking water (filter/dilutions)	\$14

* This test is performed on drinking water samples that test positive for Total Coliform by the membrane filtration method. It is used to verify the presence of Total Coliform and simultaneously test for Fecal Coliform and E. Coli.

6.2 CHEMICAL ANALYSIS PER ANALYSIS

Metals/Inorganics

Metals by Flame AA and Flame Emission Screen	\$21 per element
Batch of 8 to 19	\$43 per element
Batch of 20 or more	\$24 per element
Metals by Graphite Furnace AA	
Batch of 1 to 19~	\$47 per element
Batch of 20 or more	\$32 per element
Digestion for non-drinking water samples	\$28 per sample
ICPMS 21 element screen*	\$260 per sample
ICPMS (less than 20 samples, 3 to 7 elements/sample	\$26 per element
ICPMS (20 or more samples for 3 to 7 elements or	
10 or more samples for 8 or more elements)	\$17 per element
ICPMS Mercury	\$57 per sample
Metals Filtration	\$25 per sample

~ If two or more metals can be analyzed simultaneously, then 10 samples of two metals qualify for volume discount.

* ICPMS screen includes: Al, Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, K, Mn, Na, Ni, Pb, Sb, Se, Sn, Ti, Zn

Titration

Total Alkalinity	\$23 per sample
— Batch of 10 or more	\$17 per sample
Calcium or Hardness, edta	\$26 per sample
— Batch of 10 or more	\$20 per sample

Organics

Total Trihalomethanes (TTHMs)	\$106
Total Organic Carbon (TOC)	\$32
Haloacetic Acids (HAAs)	\$154
Dissolved Organic Carbon (DOC)	\$43
DBP Formation/Simulate, Distribution System (prep only)	\$91

Nutrients

Total Nitrogen	\$28
Total Phosphorus	\$28
Nitrate Nitrite	\$27
Soluble Reactive Phosphorus	\$27

Other Procedures

Color	\$10
Copper (comparator, colorimetric)	\$12
Fluoride (potentiometric)	\$16
Iron (colorimetric comparator)	\$12
pH, potentiometric	\$16
Specific conductance	\$12
Turbidity	\$10
Chlorine Residual, colorimetric	\$12
Chlorine Demand	
Single contact time at the requested temperature, pH, and Cl ₂ dosage	\$113
For each additional contact time, temperature, pH or Cl ₂ dosage on the same water source.	\$39
Seepage (minimum or sum of parameters tested)	\$64
UVA (254-545)	\$15
SOC-VOC Screen	\$182
VOC Screen	\$148
Nitrate Nitrite Screen and UVA	\$31
Solids, Total Suspended	\$33
Solids, Total Dissolved	\$33

6.3 LIMNOLOGICAL ANALYSIS PER SAMPLE

Algal biovolume and identification to genus	\$63
Algal Toxins	\$62
Flavor Profile Analysis (FPA) and Flavor Rating Assessment (FRA)	\$75))

7. AUTHORITY/REFERENCES

Seattle Municipal Code 21.04.100, 21.04.105, 21.04.125, 21.04.465, 3.02

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

**APPENDIX C-5
Water Rates**

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SEATTLE PUBLIC UTILITIES
ADOPTED RETAIL WATER RATES

Effective January 1, 2018

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
Direct Service													
RATE SCHEDULES	Inside City				Outside City				City of Shoreline / City of Lake Forest Park				
	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	MMRD* w/PUT
Commodity Charge (\$/100 Cubic Feet)													
Offpeak Usage (Sept 16-May 15)	\$5.20	\$5.20	\$5.20		\$5.93	\$5.93	\$5.93		\$6.31	\$6.31	\$6.31		\$5.91
Peak Usage (May 16-Sept 15)													
Up to 5 ccf**	\$5.33	\$5.33	\$6.59		\$6.08	\$6.08	\$7.51		\$6.46	\$6.46	\$7.99		\$6.05
Next 13 ccf**	\$6.59	\$6.59	\$6.59		\$7.51	\$7.51	\$7.51		\$7.99	\$7.99	\$7.99		\$7.48
Over 18 ccf**	\$11.80	\$11.80	\$6.59		\$13.45	\$13.45	\$7.51		\$14.31	\$14.31	\$7.99		\$13.39
Usage over base allowance				\$20.00				\$22.80				\$24.30	
Utility Credit (\$/month)	\$21.15		\$12.38		\$21.15		\$12.38		\$21.15		\$12.38		
Base Service Charge (\$/month/meter)													
3/4 inch and less	\$16.10		\$16.10		\$18.35		\$18.35		\$19.55		\$19.55		
1 inch	\$16.60		\$16.60		\$18.90		\$18.90		\$20.15		\$20.15		
1-1/2 inch	\$25.60	\$25.60	\$25.60		\$29.20	\$29.20	\$29.20		\$31.05	\$31.05	\$31.05		\$29.05
2 inch	\$28.35	\$28.35	\$28.35	\$16.25	\$32.30	\$32.30	\$32.30	\$19.00	\$34.40	\$34.40	\$34.40	\$20.00	\$32.20
3 inch	\$104.95	\$104.95	\$104.95	\$21.00	\$119.65	\$119.65	\$119.65	\$24.00	\$127.30	\$127.30	\$127.30	\$25.00	\$119.15
4 inch	\$150.40	\$150.40	\$150.40	\$39.00	\$171.45	\$171.45	\$171.45	\$44.00	\$182.40	\$182.40	\$182.40	\$47.00	\$170.70
6 inch		\$185.05	\$185.05	\$66.00		\$210.95	\$210.95	\$75.00		\$224.40	\$224.40	\$80.00	\$210.00
8 inch		\$218.00	\$218.00	\$105.00		\$249.00	\$249.00	\$120.00		\$264.00	\$264.00	\$127.00	\$247.00
10 inch		\$297.00	\$297.00	\$152.00		\$339.00	\$339.00	\$173.00		\$360.00	\$360.00	\$184.00	\$337.00
12 inch		\$402.00	\$402.00	\$222.00		\$458.00	\$458.00	\$253.00		\$488.00	\$488.00	\$269.00	\$457.00
16 inch		\$477.00	\$477.00			\$544.00	\$544.00			\$579.00	\$579.00		\$542.00
20 inch		\$614.00	\$614.00			\$700.00	\$700.00			\$745.00	\$745.00		\$697.00
24 inch		\$771.00	\$771.00			\$879.00	\$879.00			\$935.00	\$935.00		\$875.00

* Master Metered Residential Development
 ** per residence

Effective January 1, 2019

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
Direct Service													
RATE SCHEDULES	Inside City				Outside City				City of Shoreline / City of Lake Forest Park				
	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	MMRD* w/PUT
Commodity Charge (\$/100 Cubic Feet)													
Offpeak Usage (Sept 16-May 15)	\$5.27	\$5.27	\$5.27		\$6.01	\$6.01	\$6.01		\$6.39	\$6.39	\$6.39		\$5.98
Peak Usage (May 16-Sept 15)													
Up to 5 ccf**	\$5.41	\$5.41	\$6.69		\$6.17	\$6.17	\$7.63		\$6.56	\$6.56	\$8.11		\$6.14
Next 13 ccf**	\$6.69	\$6.69	\$6.69		\$7.63	\$7.63	\$7.63		\$8.11	\$8.11	\$8.11		\$7.59
Over 18 ccf**	\$11.80	\$11.80	\$6.69		\$13.45	\$13.45	\$7.63		\$14.31	\$14.31	\$8.11		\$13.39
Usage over base allowance				\$20.00				\$22.80				\$24.30	
Utility Credit (\$/month)	\$21.86		\$12.38		\$21.86		\$12.38		\$21.86		\$12.38		
Base Service Charge (\$/month/meter)													
3/4 inch and less	\$17.15		\$17.15		\$19.55		\$19.55		\$20.80		\$20.80		
1 inch	\$17.70		\$17.70		\$20.20		\$20.20		\$21.45		\$21.45		
1-1/2 inch	\$27.25	\$27.25	\$27.25		\$31.05	\$31.05	\$31.05		\$33.05	\$33.05	\$33.05		\$30.95
2 inch	\$30.20	\$30.20	\$30.20	\$17.25	\$34.45	\$34.45	\$34.45	\$20.00	\$36.65	\$36.65	\$36.65	\$21.00	\$34.30
3 inch	\$111.80	\$111.80	\$111.80	\$22.00	\$127.45	\$127.45	\$127.45	\$25.00	\$135.60	\$135.60	\$135.60	\$27.00	\$126.90
4 inch	\$160.20	\$160.20	\$160.20	\$41.00	\$182.65	\$182.65	\$182.65	\$47.00	\$194.30	\$194.30	\$194.30	\$50.00	\$181.85
6 inch		\$197.10	\$197.10	\$71.00		\$224.70	\$224.70	\$81.00		\$239.05	\$239.05	\$86.00	\$224.00
8 inch		\$232.00	\$232.00	\$112.00		\$264.00	\$264.00	\$128.00		\$281.00	\$281.00	\$136.00	\$263.00
10 inch		\$297.00	\$297.00	\$161.00		\$339.00	\$339.00	\$184.00		\$360.00	\$360.00	\$195.00	\$337.00
12 inch		\$402.00	\$402.00	\$235.00		\$458.00	\$458.00	\$268.00		\$488.00	\$488.00	\$285.00	\$457.00
16 inch		\$477.00	\$477.00			\$544.00	\$544.00			\$579.00	\$579.00		\$542.00
20 inch		\$614.00	\$614.00			\$700.00	\$700.00			\$745.00	\$745.00		\$697.00
24 inch		\$771.00	\$771.00			\$879.00	\$879.00			\$935.00	\$935.00		\$875.00

* Master Metered Residential Development

** per residence

Effective January 1, 2020

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
Direct Service													
RATE SCHEDULES	Inside City				Outside City				City of Shoreline / City of Lake Forest Park				
	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	MMRD* w/PUT
Commodity Charge (\$/100 Cubic Feet)													
Offpeak Usage (Sept 16-May 15)	\$5.40	\$5.40	\$5.40		\$6.16	\$6.16	\$6.16		\$6.55	\$6.55	\$6.55		\$6.13
Peak Usage (May 16-Sept 15)													
Up to 5 ccf**	\$5.55	\$5.55	\$6.86		\$6.33	\$6.33	\$7.82		\$6.73	\$6.73	\$8.32		\$6.30
Next 13 ccf**	\$6.86	\$6.86	\$6.86		\$7.82	\$7.82	\$7.82		\$8.32	\$8.32	\$8.32		\$7.79
Over 18 ccf**	\$11.80	\$11.80	\$6.86		\$13.45	\$13.45	\$7.82		\$14.31	\$14.31	\$8.32		\$13.39
Usage over base allowance				\$20.00				\$22.80				\$24.30	
Utility Credit (\$/month)	\$22.85		\$12.50		\$22.85		\$12.50		\$22.85		\$12.50		
Base Service Charge (\$/month/meter)													
3/4 inch and less	\$18.45		\$18.45		\$21.05		\$21.05		\$22.40		\$22.40		
1 inch	\$19.00		\$19.00		\$21.65		\$21.65		\$23.05		\$23.05		
1-1/2 inch	\$29.35	\$29.35	\$29.35		\$33.45	\$33.45	\$33.45		\$35.60	\$35.60	\$35.60		\$33.30
2 inch	\$32.50	\$32.50	\$32.50	\$17.75	\$37.05	\$37.05	\$37.05	\$20.00	\$39.40	\$39.40	\$39.40	\$22.00	\$36.85
3 inch	\$120.30	\$120.30	\$120.30	\$23.00	\$137.15	\$137.15	\$137.15	\$26.00	\$145.90	\$145.90	\$145.90	\$28.00	\$136.55
4 inch	\$172.35	\$172.35	\$172.35	\$43.00	\$196.50	\$196.50	\$196.50	\$49.00	\$209.00	\$209.00	\$209.00	\$52.00	\$195.60
6 inch		\$212.00	\$212.00	\$73.00		\$242.00	\$242.00	\$83.00		\$257.00	\$257.00	\$89.00	\$241.00
8 inch		\$250.00	\$250.00	\$115.00		\$285.00	\$285.00	\$131.00		\$303.00	\$303.00	\$139.00	\$284.00
10 inch		\$305.00	\$305.00	\$166.00		\$348.00	\$348.00	\$189.00		\$370.00	\$370.00	\$201.00	\$346.00
12 inch		\$412.00	\$412.00	\$242.00		\$470.00	\$470.00	\$276.00		\$500.00	\$500.00	\$293.00	\$468.00
16 inch		\$477.00	\$477.00			\$544.00	\$544.00			\$579.00	\$579.00		\$542.00
20 inch		\$614.00	\$614.00			\$700.00	\$700.00			\$745.00	\$745.00		\$697.00
24 inch		\$771.00	\$771.00			\$879.00	\$879.00			\$935.00	\$935.00		\$875.00

* Master Metered Residential Development

** per residence

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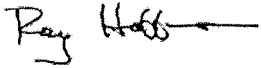
SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

**APPENDIX C-6
Water Availability Certificates**

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Policy and Procedure

Title Water Availability Certificates (WACs)	Number CS-101
Responsibility Drinking Water Division	Supersedes 2003 version
SPU Director's Approval  Ray Hoffman	Effective Date May 9, 2011

1. PURPOSE

To establish policies for Seattle Public Utilities for issuance of Water Availability Certificates (WACs) in response to either certain applications within SPU Water's direct service area for the issuance of building permits, land use permits, or to customer requests for information about SPU's infrastructure and capacity requirements.

2. ORGANIZATIONS AFFECTED

- City of Seattle, Seattle Public Utilities
- City of Seattle, Department of Planning and Development
- City of Seattle, Fire Department
- King County Department of Building and Land Use
- King County Fire Districts
- City of Shoreline, Planning and Development Services
- Shoreline Fire District
- City of Burien
- City of Renton
- City of Lake Forest Park
- Developers/potential developers within SPU Drinking Water's direct service area

3. DEFINITIONS

Condominium is a type of housing consisting of one or more multiple-unit buildings. Each unit is owned separately but the surrounding land is owned in common. For purposes of this policy, the entire condominium is considered a single legal parcel.

Cottage-style development is a type of multi-family housing consisting of detached, separately-owned units with the surrounding land owned in common. For purposes of this policy, the entire cottage-style development is considered a single legal parcel.

Developer is a property owner, or a property owner's designee, who is building a structure to be supplied with water service on at least one legal parcel.

Engineering standards are Seattle Standard Specifications and Standard Plans, professional and technical society standards (such as AWWA, APWA), and City memoranda specifying design standards.

Frontage, for the purposes of this policy, is a boundary of any legal parcel or unit lot abutting a street right of way which is at least ten feet wide.

If the parent lot of a subdivision has frontage on more than one street right of way, the resulting lots are considered to have frontage on the street right of way nearest to the boundary.

If the parent lot of a subdivision has frontage on only one street right of way, all of the resulting lots are considered to have frontage on the same street right of way as the parent lot.

Landlocked Lot is a parcel or unit lot which has no street right of way within ten feet of any part of the boundary.

Master meter is a metered water service from a SPU-owned water main, serving more than one legal parcel or unit lot.

No-tap main is a water main for which SPU has determined that no new services shall be installed. Examples of no-tap mains are transmission or large diameter feeder mains, substandard mains with capacity inadequate for service, and mains from a different pressure zone. In some circumstances a main may be a no-tap main for services on only one side of the street.

Private water line is the customer-owned water pipe that extends from the end of the SPU water service at the city union point.

Standard water main is an SPU main which meets current size and material engineering standards and which can deliver required flows to service the project and surrounding area.

Townhouse, or unit lot subdivision, is a type of high-density residential development consisting of single or multiple-unit buildings. Each unit and its surrounding land are separately owned. For purposes of this policy, each unit lot is considered a separate legal parcel.

Union is a coupling at the end of SPU's water service connecting the public water service to the privately owned water service.

Water service is the portion of the SPU water distribution system dedicated to providing metered water service to a specific account. The water service begins at the water main, continues through the meter, and ends at the city union point.

4. GENERAL POLICIES

- A. SPU will offer all customers in like circumstances the same requirements, services, agreements, or privileges.
- B. WACs provide information on the SPU water system only. Information about on-site or privately owned water mains and/or hydrants is not included. The WAC document includes the following information:

- 1) Location of the property, including street address or Assessor's Parcel Number, and SPU map number.
 - 2) Type of certificate (Inquiry, Meter Only, Building Permit or Land Use).
 - 3) Certificate number, date of issue, and certifier's name.
 - 4) Description of existing service(s) if any, including size, type and material.
 - 5) Pressure zone and elevation.
 - 6) Description of existing water main (if any), including size, material, installation date and distance from margin.
 - 7) Description of hydrant, including distance from site and flow test or flow model, if available
- C. Requirements for water service will be determined prior to issuing the WAC. An approved WAC is required for approval of building and land use permits.
- 1) If an existing water service will be retained with no change, OR if the proposed project does not require water service, OR if water service is available at the project site with no changes to the existing distribution system, the WAC will be approved.
 - 2) If changes to the distribution system are required to provide water to the project, the WAC will not be approved, and the required changes to the distribution system will be described on the WAC.
 - 3) An Approved with Contract WAC will be issued when the property-owner/developer signs SPU's Property Owner Contract to Change SPU's Distribution System and pays the required fees.
 - 4) If the proposed project changes, the WAC will be re-evaluated. Changes to the project may result in increased requirements for water service.
- D. SPU may reduce or waive the water main requirements under this policy, or may require an alternate improvement of equal or lesser cost, if such changes best serve the distribution system.
- E. In some conditions (e.g., 20 percent or greater slopes, riparian corridors or other geological barriers, poor soil) the public right of way may be inappropriate for water main operation. The requirement to install a water main may be waived in such circumstances. SPU will determine on a case-by-case basis whether engineering remedies exist which would suffice for the construction of a main extension.
- F. In special circumstances, the system may be best served by installation of a water main larger than required by this policy. In such cases, SPU will pay the difference in materials cost between the required standard main and the desired size.
- G. In some circumstances, including but not limited to state highways, divided roads, presence of active railroad tracks, or other obstructions in the right of way, installation of a standard water main to serve each side of the road may be required.
- H. Conditions not specifically described in this policy, including but not limited to multiple households on a single service, relocation of an existing service, increasing the size of an existing service, multiple services to the same legal parcel, and "no-man's land" areas not included in any existing water district, shall be evaluated on a case-by-case basis.
- I. The property owner or developer may appeal the requirements made on the WAC by calling or writing to SPU. The WAC Review Committee will review the project and respond within two (2) weeks after receipt of the appeal to all interested parties, including the person appealing and other affected agencies. A revised WAC will be issued if required.

5. REQUIREMENTS FOR NEW WATER SERVICE

- A. If no frontage of a parcel or unit lot abuts an existing standard water main, a standard water main will be extended to cross the full frontage of the property, and a portion of the adjoining street and/or alley, if any.
- B. Unless landlocked, a parcel or unit lot must have at least ten feet of frontage abutting an existing standard water main to obtain water service from that main. The ten-foot width must be maintained from the frontage to the parcel or unit lot.
- C. For parcels or unit lots with frontage on only one street or right of way:
 - 1) If there is an existing standard water main in that right of way, service shall be provided from that main.
 - 2) If there is not an existing standard water main in that right of way, a standard main will be extended across the full frontage of the legal parcel, and a portion of the adjoining alley, if any.
 - 3) SPU shall waive the requirement to install a standard water main if
 - a. The parcel is located in a single family zone, AND
 - b. The parcel is the last developable, single-family lot on the block, as determined by the permit-issuing agency with jurisdiction over it, AND
 - c. There is no existing water main on the block.
- D. For parcels or unit lots with frontage on more than one street right of way:
 - 1) If there are existing standard water mains on more than one frontage, SPU shall determine which main shall provide water service to the parcel.
 - 2) If a parcel or unit lot has frontage abutting only one existing standard water main, service shall be provided from that main.
 - 3) If there are no existing standard water mains on any frontage, SPU may require installation of a standard water main across the full frontage of the legal parcel, and a portion of the adjoining alley, if any.
- E. If a parcel or unit lot is landlocked (has no frontage within ten feet of any right of way), SPU may require the Developer to install a water main on private property, to be owned by SPU. Landlocked parcel(s) or unit lot(s) for which SPU determines not to require a water main shall be served via private water lines through private easements, or through a master meter.
- F. If the parent lot of a subdivision, including unit lot subdivisions, is more than 200 feet deep as measured from the property line at the public right of way to the point farthest away from it, SPU may require the Developer to install a water main on private property, to be owned by SPU.
- G. New water mains installed under this policy shall follow current City of Seattle Plans and Specifications and SPU water main design standards.
- H. Private water lines shall be on private property unless specifically approved by SPU and SDOT.
- I. At SPU's discretion, new services may be installed each in a separate standard meter box (individual), or consolidated together into larger vaults and connected to the main with manifold piping, whereby each group of services is supplied from a single tap on the existing or newly installed water main in the public right of way.

- J. The easement for an SPU-owned main on private property must be at least twenty feet wide.
- K. Private water lines in easements may be bundled if desired.
- 1) Bundled private water lines shall be installed in a casing pipe.
 - 2) Each private water line in the bundle shall be separately identified.
- L. The easement for one private water line or for a casing pipe containing bundled private water lines must be at least 5 feet wide. If more private water lines will be installed in any portion of an easement, a minimum of one additional foot of easement width must be allowed for each additional private water line. The easement must be continuous from the water meter to the parcel or unit lot served by that meter.
- 1) The easement must be obtained by the developer, recorded, and a copy provided to SPU at the time of ordering water service.
 - 2) Individual and bundled private water lines in easements shall be impermeable to petroleum products.
- M. Cottage developments shall be served by an SPU master meter. Private submeters may be used if desired.
- N. A common fire and/or irrigation service may be installed to serve properties which have individual domestic services (e.g., live/work townhouses with a common garage).
- O. A covenant and a homeowners' association are required for legal parcels which are served by a master meter (with or without private submeters) OR by a privately owned water distribution system, OR which share a common fire and/or irrigation service. To order water service for the project, the Developer must provide:
- 1) A signed, recorded covenant for each legal parcel/living unit within the boundary of the project stating that SPU will not separate shared water service(s).
 - 2) Documentation of the creation of a homeowners' association or other entity which will be responsible for the operation, maintenance, repair, replacement of the privately owned piping and/or shared water service as well as the payment of all SPU utility charges.
 - 3) SPU will not read or bill any privately owned water meters from privately owned water systems.
- P. Lot boundary adjustments which have the effect of avoiding water main installation requirements under this policy shall not be considered by SPU when such determination is made.

6. AUTHORITY/REFERENCES

- RCW 80.28.080, Gas, electrical, and water companies
- SMC 21.040.060, Water rates and regulations

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-7

Water Service Within the Direct Service Area

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Seattle Public Utilities - Policy & Procedure

Subject: Water Service within the Direct Service Area	Number: SPU-CS-102	
	Effective: October 17, 2003	
	Supersedes: SPU-CS-010 (12/30/83) 400P-23-05 (9/01/82)	
Approved: 	Department: Seattle Public Utilities	Page(s):

1.0 PURPOSE

To establish policies and procedures for Seattle Public Utilities for granting water service connections to its water distribution system within its direct service area.

2.0 ORGANIZATIONS AFFECTED

- 2.1 City of Seattle, Seattle Public Utilities (SPU)
- 2.2 City of Shoreline
- 2.3 King County
- 2.4 Customers residing near and within SPU's direct water service area

3.0 AUTHORITY FOR RULE

- 3.1 Revised Code of Washington 35.91; 35.92; 80.28.080
- 3.2 Seattle Municipal Code 21.04
- 3.3 Most current SPU Water System Plan

4.0 GENERAL POLICIES

4.1 Standards and Requirements for New Services

- 4.1.1 All new SPU water service connections will be connected to a standard water main designed to serve that property. (see also Policy SPU-CS-101, Water Availability Certificates)
- 4.1.2 All water service connections to SPU's water distribution system will be metered and either monthly or bi-monthly bills will be sent to the property owner or owner's designee,
 - 4.1.2.1 The only exception to the above metering and billing policy will be for the fire services on Interstate Highways 5 and 90.
- 4.1.3 Application for water service by the property owner will be approved when SPU has issued a current, approved Water Availability Certificate, and when SPU has been provided with the following:
 - 4.1.3.1 SPU's application for water service form completed and signed by the property owner, and

- 4.1.3.2 the common street address and legal description of the parcel to be served, and
 - 4.1.3.3 utility plans showing all existing and proposed utilities
 - 4.1.3.4 all recorded easements needed for private service lines, when applicable.
 - 4.1.3.5 payment of the current standard or estimated deposit fees for installation, and
 - 4.1.3.6 payment of the street use permit if applicable, and
 - 4.1.3.7 payment of the Connection Charge in full (see Policy _____, Connection Charge), or entering into SPU's finance contract for its payment over a 10-year period
- 4.1.4 Each legal parcel will be served by one domestic water service, except
- 4.1.4.1 When SPU has allowed or required parcels not abutting a water main to be served by either a privately owned water main or long service lines, a covenant or homeowner bylaws will be filed with those parcels to run with the land and prohibit the property owners of those parcels from requesting individual service directly from SPU's distribution system.
 - 4.1.4.2 Certain parcels may be served by more than one domestic service due to the use of the property, i.e., hospitals, nursing homes and similar facilities, to assure continuous uninterrupted water service. Each service will be from separate water mains abutting the parcel when possible.
 - 4.1.4.3 A community containing more than one legal parcel and either more than 350 feet of private road, or a gated private road of any length, will be served with one domestic meter at the perimeter of that community of legal parcels.

It may be possible that a second SPU domestic service be available to this community's private system from a second SPU-owned water main if needed to provide reliability via a "looped" private water system, i.e., a system having two separate sources of water from the SPU distribution system. Both domestic services would be located at the perimeter of the community of legal parcels. (see also Sec. 4.4.5 of Policy SPU-CS-101, WACs)

- 4.1.4.4 One very large parcel of land which contains a privately owned water distribution system may be served by more than one domestic service to provide reliability via a "looped" private water system (e.g., the University of Washington campus).
- 4.1.4.5 One property may not serve another with water service, unless explicitly approved by both SPU and the affected property owners for a temporary, specified time period.
- 4.1.4.6 Each legal parcel will be eligible for separate water service for irrigation in addition to other domestic service.
- 4.1.4.7 Each legal parcel will be eligible for separate fire-only service.
- 4.1.5 Fire-only water services will consist of a detector check valve and a bypass meter assembly.
 - 4.1.5.1 Water may be used at no charge for testing of the on-property fire suppression system monthly as follows:
 - ◆ 100 cubic feet for fire services 1-to-2 inches
 - ◆ 500 cubic feet for fire services 3-to-5 inches
 - ◆ 1,000 cubic feet for fire services larger than 5 inches
 - 4.1.5.2 The detector check valve will be changed by SPU, at the property owner's expense, to a fully metered fire service if water used at the property regularly exceeds the above limits set for system testing
- 4.1.6 If a property's water service will be used solely or in part for an internal fire suppression system (e.g. sprinkler heads), the property shall not be served by a water service less than one inch (1") in size.
- 4.1.7 Water service to direct service area customers will be from SPU's distribution water main system and not from its supply or transmission pipelines.
- 4.1.8 Water services up to two inches (2") in size will be charged a reduced installation rate when
 - 4.1.8.1 a new water main to serve the property and to be owned by SPU is installed by a property owner, and
 - 4.1.8.2 the property owner's contractor will trench for SPU's service line and backfill the trench.

4.1.9 Water service to customers within SPU's direct service area may be obtained from a water purveyor whose distribution system abuts the property within SPU's direct service area and SPU requests this purveyor in writing to provide temporary service to a particular property until SPU is ready to serve from its own distribution system.

4.1.10 SPU will consider an application for water service to a property not located within its direct service area only when

4.1.10.1 SPU's water service pipe and meter will be within SPU's direct service area, and

4.1.10.2 the water utility whose direct service area includes this property has requested SPU in writing to serve this property until such time as that utility is prepared to serve it directly, and all other applicable requirements in SPU's policies have been fulfilled.

~~4.1.11 Temporary water service from the distribution system for less than six months may be authorized via a hydrant use permit or hydrant use meter issued by SPU Customer Services if no other source of water is available. No administrative or water usage charges for hydrant permit holders will be made for water main installation projects sponsored by SPU and for which SPU will pay all project costs.~~

~~4.1.11.1 Hydrant use without a hydrant permit or hydrant meter, or use of a restricted hydrant, will result in monetary penalties in addition to all other hydrant use charges:
\$ 300 penalty for the first occurrence
\$ 500 penalty for the second occurrence
\$1,000 penalty for the third and subsequent occurrence~~

~~4.1.11.2 Permits may be issued if water use will be for less than 8,000 gallons per day~~

~~4.1.11.3 Permit holder will pay a permit fee as well as a daily charge for the water used. Payment may be made either in advance of service, or subsequent to service following a billing by SPU. A billing fee will be charged for payments made subsequent to service.~~

~~4.1.11.4 Permit holder will use an SPU supplied (or approved) hydrant valve.~~

~~4.1.11.5 Permit holder will pay SPU for any hydrant repairs necessitated by the improper operation of the hydrant at a time and material basis.~~

~~4.1.11.6 Hydrant meters will be required either~~

~~4.1.11.6.1 at the discretion of SPU Customer Services, or~~

~~4.1.11.6.2 under the following circumstances:~~

~~◆ water use will exceed 8,000 gallons per day, and~~

~~◆ use will be longer than 30 days, and~~

~~◆ no other acceptable or practical method of measuring
or estimating actual water used is practical, and~~

~~◆ one hydrant only will be used, and~~

~~◆ projected weather conditions will permit the meter to
be used without danger of freezing its parts.~~

4.1.12 Metered service will be required when temporary water is needed from one location for longer than six months.

4.2 Standards and Requirements for Changes to Existing Services

4.2.1. Existing substandard water service will be brought to standard water service whenever possible.

4.2.1.1 When a distribution main is installed which extends the distribution system to abut properties not formerly served by an abutting main, or to serve properties not formerly served by a main designed to serve that property, each property will abandon the service line to the nonabutting main and receive service from the main designed to serve or abutting the property.

4.2.1.1.1 Property owner will not be responsible for the cost either for SPU to retire the existing water service if it is two inches (2") in size or smaller, or for SPU to relocate an existing two-inch (2") or smaller water service. (see also Policy _____ Connection Charge)

4.2.1.1.2 Property owner will be responsible for the SPU costs for retirement and relocation of the existing water service if it is larger than two inches (2"). (see also Policy _____ Connection Charge)

4.2.2. When a water main is replaced, existing water services from that segment of water main will be transferred to the new main, the property owner will not be responsible for either retirement or new installation charges.

- 4.2.3. When the City or SPU changes the street or other infrastructure abutting a property with substandard water service, that water service will be changed to conform to standard practices in preparation for other changes to or in the street.
- 4.2.4. Property owners may request changes in the size of their water service, the location of their meter along the frontage of their property, and the type of use of their existing water service.
 - 4.2.4.1. When increasing a service size, SPU will both retire an existing service and tap for a new service and property owner will pay SPU standard or time-and-material charges.
(see also Policy _____ for Connection Charge.)
 - 4.2.4.2. When decreasing a two-inch (2") or smaller service, SPU will reduce the size of the existing meter and property owner will pay on a time-and-material basis. Any subsequent changes to water service size at this property will require a service retirement and new tap.
 - 4.2.4.3. When decreasing a service larger than two inches (2"), SPU will both retire the existing service and tap for a new service and property owner will pay SPU standard or time-and-material charges.
 - 4.2.4.4. Property owner may request a relocation of an existing service to a site along the property's frontage, the new location may not be in a driveway or within five feet (5') of a tree. SPU will both retire the existing service and tap for a new service if the lateral distance between the old and new locations is 31 inches or greater. Property owner will pay SPU standard or time-and-material charges in keeping with the current SPU Standard, Connection and Administrative Charges.
- 4.2.5. An existing domestic, irrigation or fire service may be changed to another use at the request of the property owner if no change in size or location is needed. (see Connection Charge Policy _____)
 - 4.2.5.1. The property owner will pay for any SPU services required to change a fire-only service to a combination fire and domestic service
 - 4.2.5.2. Any other changes to meter type will be at SPU's discretion at no additional cost to the property owner when no change in water service location or size is requested by the property owner.
- 4.2.6. Property owner will be charged for SPU repair of damage to the curb stop, meter, meter setter, meter box or lid, or tailrun.

4.2.7. Termination of existing water service

4.2.7.1. Domestic (including irrigation) water service may be shut off by SPU due to either nonpayment of utility charges (see Policy 400P-23-02 Credit and Collection), at the request of the property owner, or to effect maintenance, repair or changes to the water system.

4.2.7.1.1. SPU may remove the meter at owner's expense following shut off of service

4.2.7.1.2. Property owner may request SPU, at owner's expense

- ♦ to remove the water meter to stop water and sewer services and charges during an extended vacancy at the property. The eventual reset of the water meter also will be charged to the property owner. Removal of the meter does not stop solid waste services or charges.
- ♦ to shut off the water meter to prevent damage to the property from leakage or unauthorized water use
- ♦ to retire the domestic or irrigation service to the property.

4.2.7.2. Fire service (either fire-only or combination domestic and fire) will not be terminated by SPU without written request by the property owner and written acknowledgement and concurrence by the local fire department or district.

4.2.8. SPU may retire a domestic water service after 15 years of nonuse and charge the property owner for the cost of the retirement.

4.2.9. If a jumper, not authorized by SPU, is installed to pilfer water, SPU may retire the service and charge the property for the retirement, as well as charge for estimated water and other utility services provided during the time period the jumper was in use, as determined by SPU.

5.0 PROGRAM REVIEW

Periodic review of this policy shall be performed by the SPU Customer Services Branch as changes or conditions warrant in order to ensure that it remains current and effective in guiding SPU employees. Any recommended changes will be submitted to the SPU Director for consideration.

6.0 RESPONSIBILITIES

6.1 Property owner is responsible for

- ◆ the installation, replacement or repair of the privately owned service line from the City's union to the building(s) served, including changing a private service line when the service location to the property changes in accord with this Policy
- ◆ calling SPU Customer Services for inspection of all private underground water service line installations, repairs or replacements prior to covering
- ◆ marking the desired location of a new water service before SPU installs the service
- ◆ identifying and correcting water leakage or unauthorized water usage and notifying SPU of corrections allowing SPU to inspect any repairs or corrected water use problems
- ◆ notifying SPU of changes in property ownership or owner's designee for receiving the utility billings

6.2 SPU is responsible for

- ◆ the installation, replacement or repair of the publicly owned service from the City's water main, including the tap into the main, to the City's union
- ◆ timely inspection and other customer services
- ◆ responsiveness to customer needs
- ◆ offering all customers in like circumstances the same requirements, services, contracts or agreements, or privileges
- ◆ notifying property owner of any water usage excesses through fire services to allow owner to correct any problems prior to SPU's changing the fire service from a detector check to a meter.

7.0 DEFINITIONS

7.1 Abutting water main is a main which crosses some amount of the property; it may not be a standard main designed to serve if either the abutting main does not cross the full frontage of the property and there is a developable parcel beyond the property, or if the abutting main is not standard in size or material.

7.2 Direct water service area is the retail service area served by SPU's water distribution system as defined by the most current SPU Water System Plan.

- 7.3 Domestic service is a type of water service serving all potable water used at a property except fire-only water service.
- 7.4 Fire-only water service is available to provide stand-by water service for the sole purpose of supporting fire suppression devices on property (sprinklers, private hydrants, etc.) via a detector check meter assembly. A combination fire and domestic service is a domestic water service and is not a fire-only water service.
- 7.5 Irrigation service is a type of domestic water service designed to provide irrigation-only water at a property; sewer charges are not made on the water used through irrigation-only water services.
- 7.6 Jumper is a pipe installed to allow domestic or irrigation water to freely flow from the publicly owned service line to the user without being measured or billed by a meter, usually located in the meter box when a meter has been removed or not yet installed.
- 7.7 Master meter is a metered water service from a SPU-owned water main serving more than one legal parcel due to and in accordance with established SPU policy and procedure.
- 7.8 Private water service consists of the underground pipe leading from SPU's union to the building(s) being served, including any valves, stopcock, private submeters, backflow devices, etc.
- 7.9 Retirement of water service occurs when SPU has removed the connection to its distribution system by removing the tap to the water main and all other related water service equipment
- 7.10 Standard water service exists when a property receives metered water service from a standard water main designed to serve that property
- 7.11 Substandard water service exists either when a property's water service comes from a water main not designed to serve that property (i.e., it could be an abutting or non-abutting substandard water main or a non-abutting standard main), or when a property's water service comes from a neighboring property's water service.
- 7.12 Tail run is a short length of pipe installed by SPU from the meter box to SPU's union.
- 7.13 Termination of water service may include shut off of water at the meter, removal of the water meter, or retirement of SPU's tap and service line to the property
- 7.14 Transmission or supply pipelines are used to move water from the source to the treatment plant and from the plant to the distribution system.

- 7.15 Union is a coupling at the end of SPU's water service connecting the public water service to the privately owned water service.
- 7.16 Water main designed to serve a property is a main either abutting the property or located as close to the property as possible considering barriers such as slope, soil or other conditions which make it unsafe or impractical to bring the water distribution system closer to the property. (see also Standard and Substandard Water Service)
- 7.17 Water service provides water from the distribution system to residential, industrial and commercial users within the direct service area. It includes a tap into a SPU water main and a SPU service line. (An active water service also includes a meter, tail run and union which connects to the property's private service line; an inactive water service has had the meter removed or not yet installed.)
- 7.17.1 Domestic water service is available to provide any potable water to a property, excluding fire-only water service.
- 7.17.2 Fire-only water service is available to provide stand-by water service for the sole purpose of supporting fire suppression devices on property (sprinklers, private hydrants, etc.) via a detector check meter assembly. A combination fire and domestic service is a domestic water service and is not a fire-only water service.

**SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN
APPENDIX D
MISCELLANEOUS**

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

D. MISCELLANEOUS

APPENDIX D-1
Distribution System Analyses

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Fire Flow Analysis

1 INTRODUCTION

Seattle Public Utilities (SPU) has developed a set of hydraulic network models of its water distribution system to analyze system performance. These models are used to:

- Model available fire flow in support of design of water system improvements or additions.
- Identify and prioritize fire flow improvements under certain operating conditions.
- Support operational response and public notification during a system disruption.
- Compare results of hydrant flow tests performed for customers to modeled flow, for model calibration purposes.
- Analyze distribution system performance in a seismic event.
- Identify low pressure areas needing upgrades (completed in 2009).
- Plan and stage unidirectional flushing.
- Provide system performance information to the Washington Surveying and Rating Bureau.¹
- Analyze water age in distribution system.

This document summarizes the methods and results of recent analysis of the SPU water distribution system performance and fire flow availability under certain operating conditions. The results are meant to guide planning decisions for future SPU water distribution system improvements. It is important to note that the results are not site-specific analyses nor are they meant for fire protection system design.

2 HYDRAULIC NETWORK MODELS

Due to its size and complexity, the SPU water distribution system is divided into 11 separate pressure zone hydraulic network models. This section summarizes how these models are configured and calibrated.

2.1 MODELING SOFTWARE

SPU's hydraulic models were originally created and calibrated in EPANET 2.0. Since 2014, SPU has used InfoWater v. 12 as its primary hydraulic modeling software.

¹ This analysis contributes to a Protection Class Grading for communities across Washington State. WSRB evaluates communities in four major areas: Water Supply, Fire Department, Emergency Communications and Fire Safety Control. As a result of this evaluation, the community is assigned a score of 1 through 10, where 1 indicates exemplary fire protection capabilities, and 10 indicates the capabilities, if any, are insufficient for insurance rating credit. The recent ratings for the Seattle Fire Department, King County Fire District #2 and North Highline Fire District rated SPU's water supply relatively high. The 2016 Community Protection Class Grade for the City of Seattle was 2, which is the highest for any community in Washington State.

2.2 CONFIGURATION OF MODELS

The models are full-detail, containing all water mains, storage facilities, pump stations, control valves, and fire hydrant locations in each pressure zone (see Figure 1 below). Connections to the surrounding water system (transmission pipelines and other pressure zones) are modeled by fixed-head reservoirs. Table 1, below, provides details for the models.

Table 1. SPU Water Distribution System Models

Model Name	Pressure Zone(s)	Number of Pipes	Number of Nodes
326	326 (North and South), Magnolia 330	19,900	18,600
430	Maple Leaf 430, Volunteer 430, Olympic Hills 510	11,400	10,400
BA484	Barton 484	860	840
BL509	Bitter Lake 509	1,800	1,700
CRPL Zones	Beacon 460, Skyway 500, Augusta 500/550	4,000	3,800
ML550	Maple Leaf 550	1,400	1,300
QA530 + MG480	Queen Anne 530, Magnolia 480	3,000	2,800
RH590	Richmond Highlands 590	5,100	4,700
VL530 + FH530	Volunteer 530, First Hill 530	1,300	1,200
WS498	West Seattle 498	3,600	3,400
WS585	West Seattle 585	3,500	3,300
Total (11 models, 18 pressure zones)		55,900	52,000

2.3 WATER DEMANDS

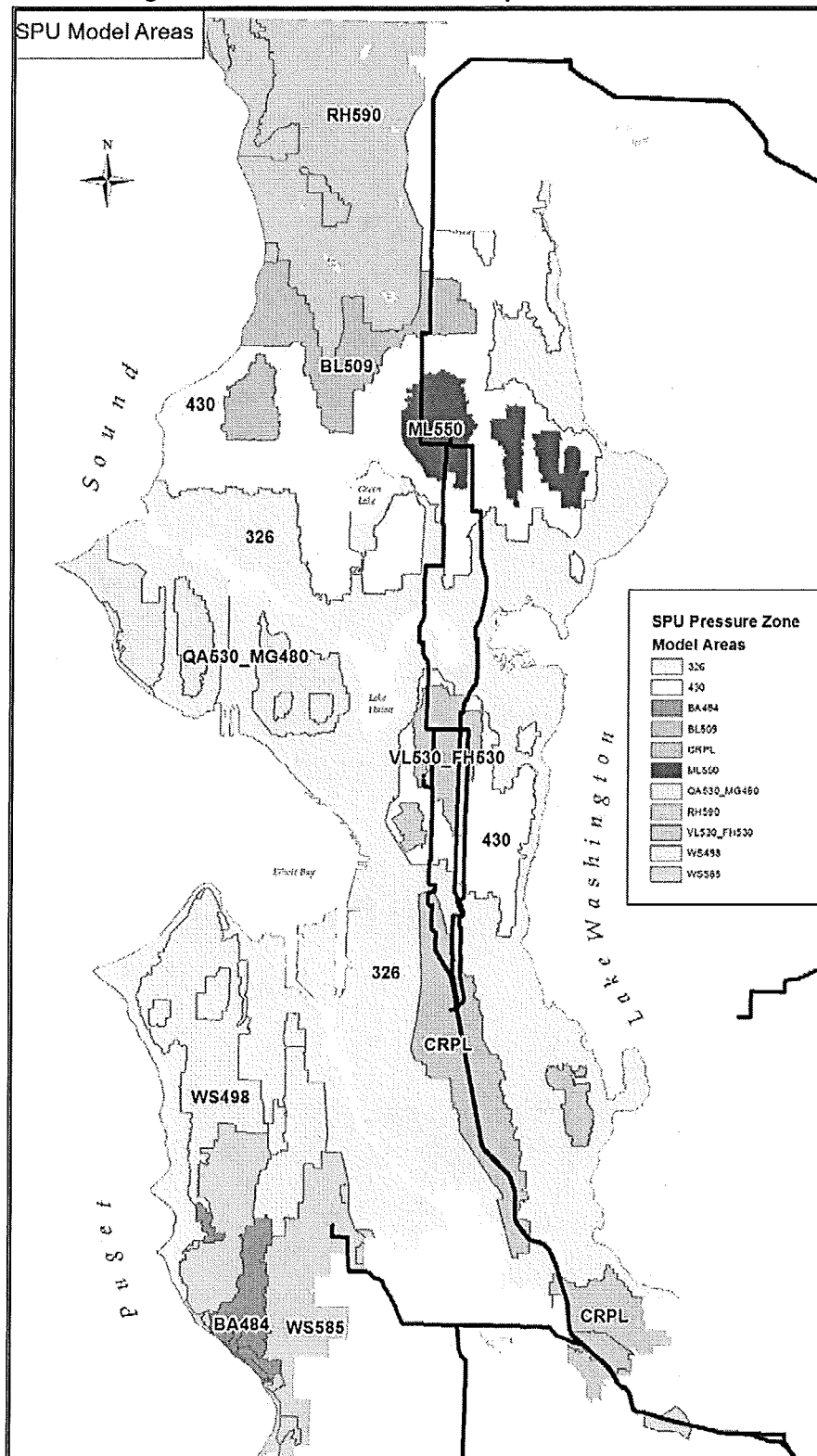
Water demand is distributed throughout each model based on total annual billed consumption for SPU's 200,000 retail service connections. Model consumption is updated annually for each model using the following process:

- Using GIS tools, annual consumption for each service line in the pressure zone(s) represented by the model is allocated to the nearest endpoint of the water line to which the service is connected.
- The aggregated annual consumption for each GIS water line point is converted from hundred cubic feet (CCF) to gallons per minute.
- Using GIS tools, the aggregated consumption at each water line node is assigned to the closest hydraulic model node. Corrections are made as necessary for geographical barriers such as freeways, water bodies, and steep slopes.
- The consumption is aggregated at each model node to determine its base demand.

Peaking factors are applied to the annual consumption data globally throughout the models. The three peaking factors used are as follows:

- Average Day Demand (ADD) – Peaking factor 1.0
- Maximum Day Demand (MDD) – Peaking factor 1.8
- Peak Hourly Demand (PHD) – Peaking factor 2.7

Figure 1. SPU Water Distribution System Model Areas



2.4 MODEL CALIBRATION AND UPDATES

2.4.1 Initial Model Setup and Calibration

SPU's water pressure zone hydraulic network models were originally created in 1998-9 through direct conversion of GIS pipe data. From the pipe data, node data was populated through geographical assignment of water consumption (from the year 1994) and topographical elevation data. Errors such as missing or misidentified pipes and unconnected pipes were corrected manually via visual observation. Finally, each model was made operational by adding volume curves for storage facilities (reservoirs and tanks) and pump curves for booster pump stations.

At the time the models were originally created, there was no data on either the internal pipe roughness (friction factor) for SPU's unlined cast iron water mains nor the exact extent of unlined cast iron pipe in SPU's water distribution system. Because of this, an extensive model calibration effort was performed involving hydrant flow testing and direct pipe roughness measurements. Over 130 hydrant flow tests were conducted between 1999 and 2003. The field calibration effort yielded important information, including typical pipe roughness values (Hazen-Williams C-Factors) for lined and unlined pipes of 120 and 40, respectively. The testing effort also confirmed the year (1940) when Seattle transitioned from unlined to lined cast iron water mains, based on simulations of hydrant flow test results.

Following the pipe roughness calibration effort, each pressure zone model was calibrated for a 24-hour extended period simulation of the peak water consumption day of 1998 (July 15, 1998). This peak day had a total systemwide consumption of 264 million gallons². By adjusting the peak day diurnal demand pattern over a 24-hour extended-period simulation, each model successfully simulated the 1998 peak day.

SPU is currently calibrating the pressure zone hydraulic models using results of hydrant fire flow tests conducted over the past 10 years. SPU expects to complete this calibration by late 2018.

2.4.2 Model Updates

SPU regularly updates its pressure zone hydraulic models to reflect current system conditions and improve model performance. The following tasks are performed to update the models:

- Base water demands are updated annually from billed water consumption using the procedure described above.
- Model pipe and junction data are manually updated annually based on updates to SPU GIS water pipe data. New pipes are assigned a Hazen-Williams C-factor of 120.
- Pipe roughness factors for unlined cast iron water mains are calibrated when verifying field hydrant flow test results. This is done by adjusting Hazen-Williams C-factors of unlined CI water mains in the area surrounding the test until the modeled pressure drop at the witnessed hydrant matches the results from the test.

It should be noted that hydrant flow tests are required by SPU for new development projects that are to be reviewed by the Seattle Fire Marshal's office, if there are no recent hydrant flow tests in the immediate area. Modeled hydrant flow data is not used for this purpose. After new hydrant flow tests

² Total systemwide peak day demand is forecast to remain below this amount through 2032.

are completed, the results are compared to the modeled data to determine if the model needs any re-calibration in that area.

3 FIRE FLOW ANALYSES

This section describes two system-wide fire flow analyses, one performed in 2011-12 and one performed in 2017. The 2011-12 analysis resulted in nine fire flow improvement projects that were completed in 2012-2016. The 2017 analysis incorporates the completed fire flow improvement projects and identifies additional areas for possible fire flow improvement projects.

3.1 2011-12 FIRE FLOW ANALYSIS

3.1.1 Fire Flow Targets

In 2011, SPU and the Seattle Fire Department (SFD) developed operational fire flow performance targets for parcels in the City of Seattle. The targets were developed to help identify and prioritize water system improvements in areas with longstanding fire flow performance issues. The targets involve providing zoning-specific fire flows to hydrants located within a 1,000-foot fire hose length of all developed properties. (SFD brings at least 1,000 feet of fire hose to fire responses.) The fire flow targets, which are based on land used zoning, are as follows:

- Single Family Residential – 1,000 gpm
- Multi-Family Residential – 1,500 gpm
- Commercial – 3,000 gpm
- Downtown/Industrial – 8,000 gpm

3.1.2 Fire Flow Analysis

The 2011-12 fire flow analysis was run using each of the pressure zone models under Year 2010 Average Day Demand (ADD), which had a total of 54.3 mgd of retail consumption³. Available fire flow was determined with a 20 psi residual pressure at the test hydrant and no pressure or velocity restrictions elsewhere in the system. The 1,000-foot fire hose length was approximated by using a 900-foot straight line distance between hydrants and center points of parcels to account for bends in the hose around structures and other obstructions. Spreadsheet tools were then used to determine for each parcel the hydrant with the highest flow within the specified distance. Spot checks were made to exclude unpassable connections such as freeways, water bodies, and steep slopes.

3.1.3 Results of Analysis

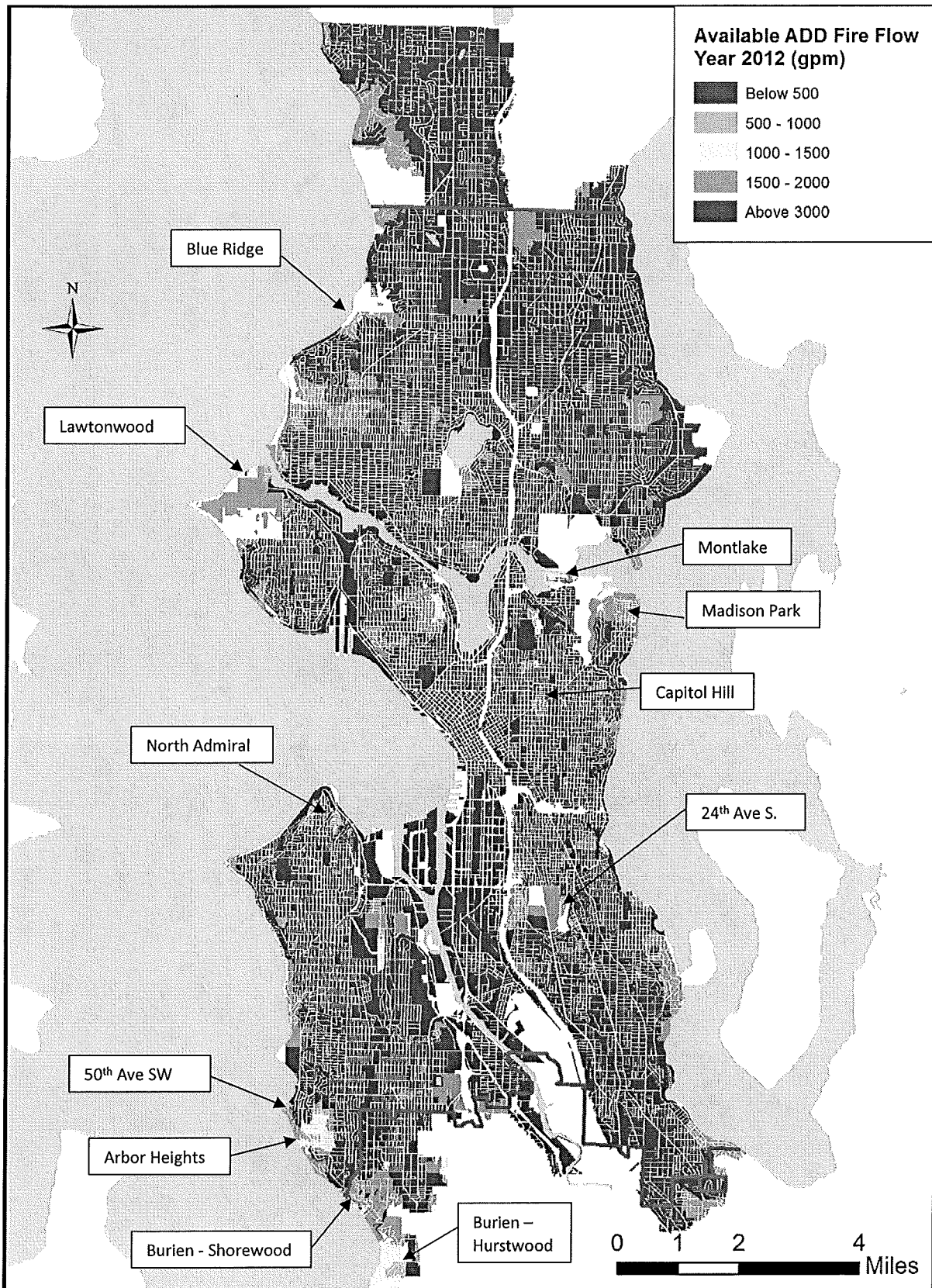
The analysis found that the majority of the over 190,000 parcels in SPU's retail service area met or exceeded the fire flow performance target, with 11 areas having less than target flow. (Eight of these areas are in Seattle and two are in the City of Burien.) The areas are listed in Table 2, below.

³ Retail consumption is forecast to stay below this level through 2035.

Table 2. Areas Not Meeting Fire Flow Performance Targets

Area	Zoning	Fire Flow Target (gpm)	No of Parcels < Target
Blue Ridge	Single Family	1,000	30
Lawtonwood	Single Family	1,000	5
Montlake	Single Family	1,000	8
Madison Park	Commercial	3,000	13
Capitol Hill	Commercial	3,000	17
North Admiral	Single Family	1,000	44
24 th Ave S	Single Family	1,000	51
50 th Ave SW	Single Family	1,000	12
Arbor Heights	Single Family	1,000	127
Burien – Shorewood	Single Family	1,000	18
Burien – Hurstwood	Single Family	1,000	123

The ADD 1,000-foot fire flow results and areas not meeting the performance target are shown in the map below.



3.1.4 Fire Flow Improvement Projects

SPU has completed nine fire flow improvement projects since the 2011-12 fire flow analysis. These projects are listed in Table 3, below.

Table 3. Fire Flow Improvement Projects Completed in 2012-16

Project Name	Land Use Zoning	Improvements	Year Completed
Arbor Heights Fire Flow Improvements	Single Family	8" replacement - 3,700 LF	2012
24 th Ave S. Fire Flow Improvements	Single Family	8" CIPP ⁽¹⁾ – 1,340 LF	2015
50 th Ave SW Fire Flow Improvements	Single Family	8" replacement – 300 LF	2015
Blue Ridge Fire Flow Improvements	Single Family	6" replacement – 550 LF 6" CIPP – 690 LF 8" replacement – 110 LF PRV station ²	2015
North Admiral Fire Flow Improvements	Commercial	8" replacement – 300 LF PRV station ⁽²⁾	2015
Burien-Shorewood Fire Flow Improvements	Single Family	PRV station ⁽²⁾	2015
Capitol Hill Fire Flow Improvements	Commercial	8" CIPP – 1,030 LF	2016
Madison Park Fire Flow Improvements	Commercial	8" CIPP – 730 LF	2016
SW Cambridge Fire Flow Improvements	Single Family	8" extension – 140 LF PRV station ⁽²⁾	2016

1) CIPP = Cured-in-place pipe lining – improves internal roughness of cast iron pipes

2) PRV station = New pressure-reducing valve station providing supplemental fire flow from adjacent pressure zone

The three remaining areas not meeting the performance target (Lawtonwood, Montlake, and Burien-Hurstwood) are waiting on external agency actions/projects before any improvements can be made. For the Lawtonwood area, SPU constructed an intertie with the Discovery Park water system and is waiting for an overall asset transfer and operations agreement with Seattle Parks and Recreation to activate it. For Montlake, SPU is waiting for WSDOT to construct their own fire flow improvements as part of the SR 520 project. For Burien-Hurstwood, SPU is waiting on a nearby private development that will construct a water main extension in Seattle's system consistent with SPU's watermain extension requirements for developers.

As an aside, the information from this analysis was added to SPU's internal GIS layers, for operational planning purposes only. The information was also made available to the Seattle Fire Department. The name of the field is "MHADDGPM20," for modeled hydrant flow at average day demand at 20 psi.

3.2 2017 FIRE FLOW ANALYSIS

3.2.1 Fire Flow Analysis Parameters

The 2017 analysis incorporates the recently completed fire flow improvement projects described in Section 3.1.4. It also utilizes the greater analytical capabilities of InfoWater versus EPANET. Based on WAC requirements and criteria used by the Washington Surveying and Rating Bureau (WSRB), the fire flow analysis was completed using the following parameters:

- Maximum Day Demand (MDD), or 1.8 times 2010 or 2015 average daily consumption, depending on model used.
- One set of runs at 20 psi residual pressure at the test hydrant while maintaining a minimum 5 psi elsewhere in the system. The 5 psi minimum was used to compare against WAC 246-290-420 (3) (Chapter 246-290 Part 5 - Water Systems Operations), which states that “When fire flow is required, 20 psi (140 kPa) at the operating hydrant and at least positive pressure shall be maintained throughout the system under fire flow conditions.”
- Another set of runs maintaining a minimum 20 psi elsewhere in the system. This was to compare against WAC 246-290-230 (1) (6), which states that “for new, or expansions to existing, distribution systems...”, “if fire flow is to be provided, the distribution system shall also provide maximum day demand (MDD) plus the required fire flow at a pressure of at least 20 psi at all points throughout the distribution system...”
- Distribution storage water levels set at 5 feet below maximum (equal to the bottom of the operating storage layer). Note that the equalizing storage component is not needed in the SPU system because of multiple supply sources being available to each pressure zone.
- Steady-state mode. Running fire flow under extended period simulations is not warranted because SPU has sufficient supply/pumping capacity to maintain storage levels while supplying MDD and fire flow demands.

3.2.2 Results of Analysis

The 2017 Fire Flow Analysis Results are shown on the maps on the following pages. The maps show the modeled available fire flow to each parcel in the SPU direct service area (DSA) within a 1,000-foot fire hose length during MDD conditions. The results are shown on an overall system map and on maps of six sub-areas.

The change from using ADD in the 2012 analysis to MDD in the 2017 analysis identified six single-family areas not meeting the 1,000-gpm, 1,000-foot fire performance target:

- Shoreline – Innis Arden
- Blue Ridge
- Montlake
- North Capitol Hill
- Burien – Shorewood
- Burien – Hurstwood

Three areas (Montlake, Burien – Shorewood, and Burien – Hurstwood) are carryovers from the 2012 ADD analysis. (Burien Shorewood provides the 1,000 gpm under MDD conditions, but requires a new hydrant to provide the flow within a 1,000-foot fire hose length.) Three other areas (Shoreline – Innis

Arden), Blue Ridge, and North Capitol Hill emerged because of the higher water demands (MDD vs ADD) used in the analysis. The areas not meeting the MDD fire flow performance target are shown on maps on the following pages.

3.2.3 Next Steps

The areas not meeting the fire flow performance target may be addressed in the following ways:

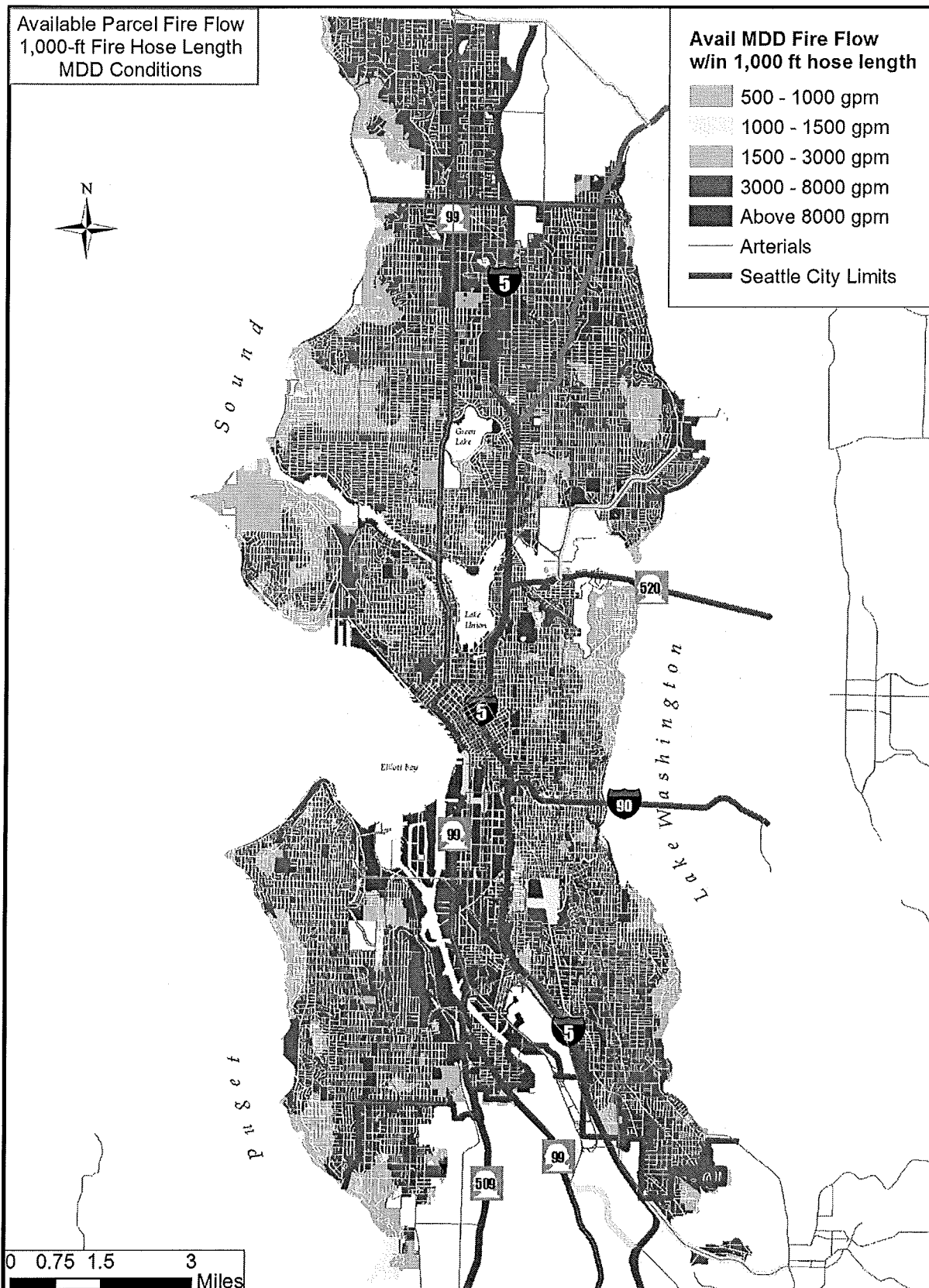
- Incorporated into the planning for future water main rehabilitation projects, especially if there are other factors (such as leak history, criticality of pipe, soil corrosivity, etc.) that combine to make the projects a high priority in the context of the overall water main replacement/rehabilitation program;
- Considered as stand-alone fire flow improvements; or
- Identified for improvement associated with watermain extension/improvements necessitated by future development. It should be noted that these projects fall under a larger category of future fire flow improvement projects that are developer-financed.

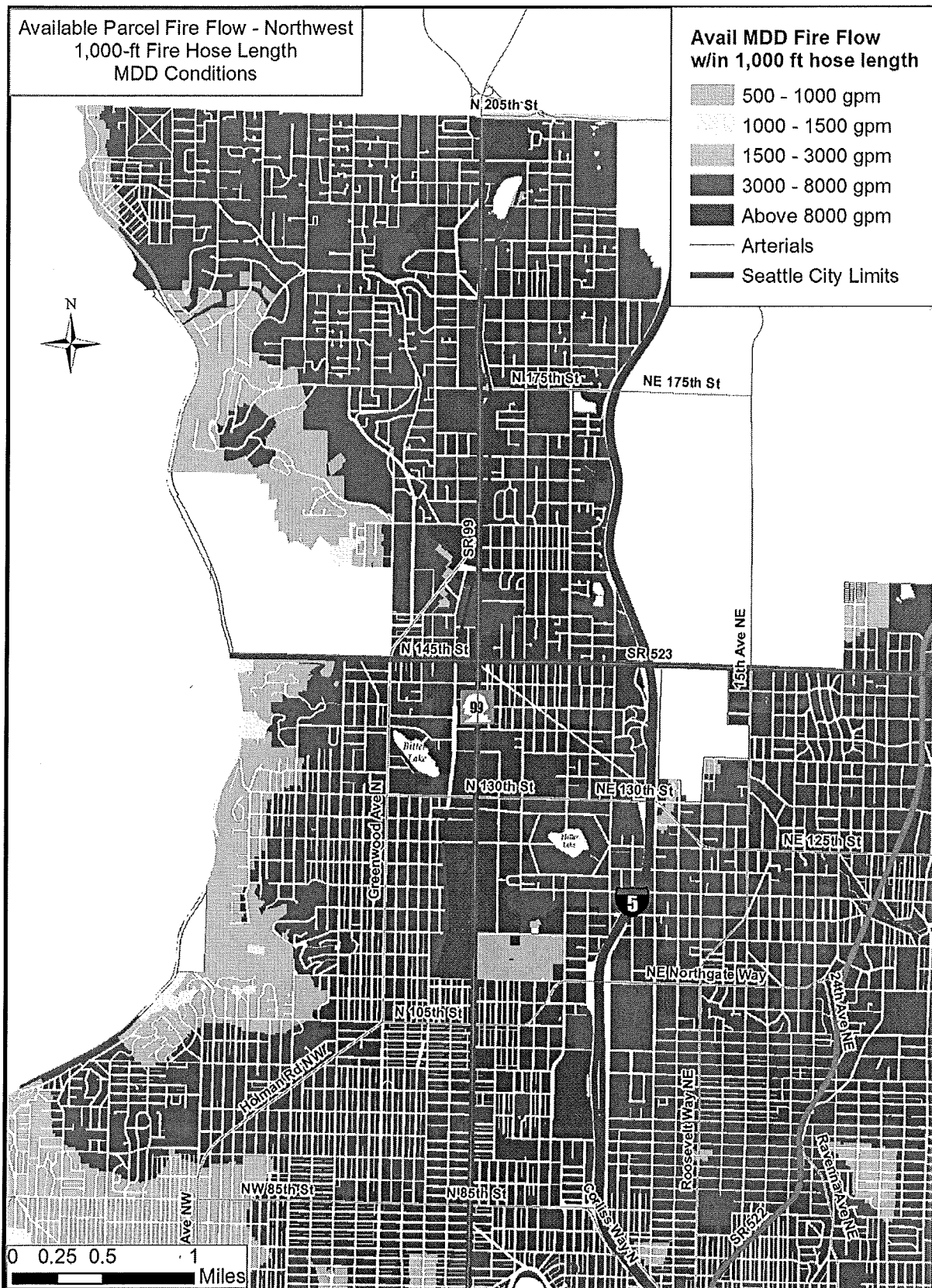
2017 Fire Flow Analysis Maps

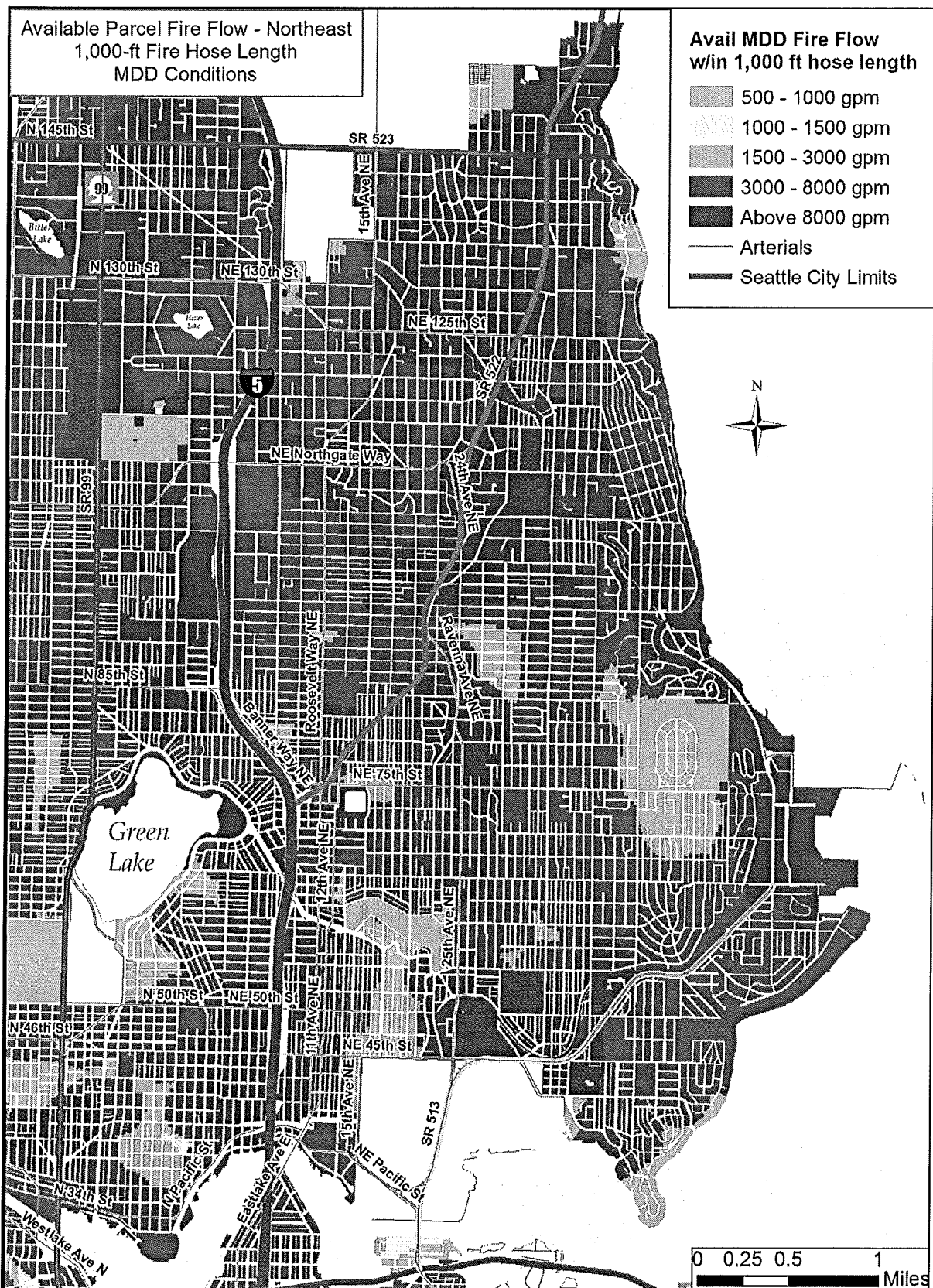
Model run at 20 psi residual pressure at test hydrant while maintaining a minimum 5 psi elsewhere in the system (5 psi used as a proxy for “positive pressure”)

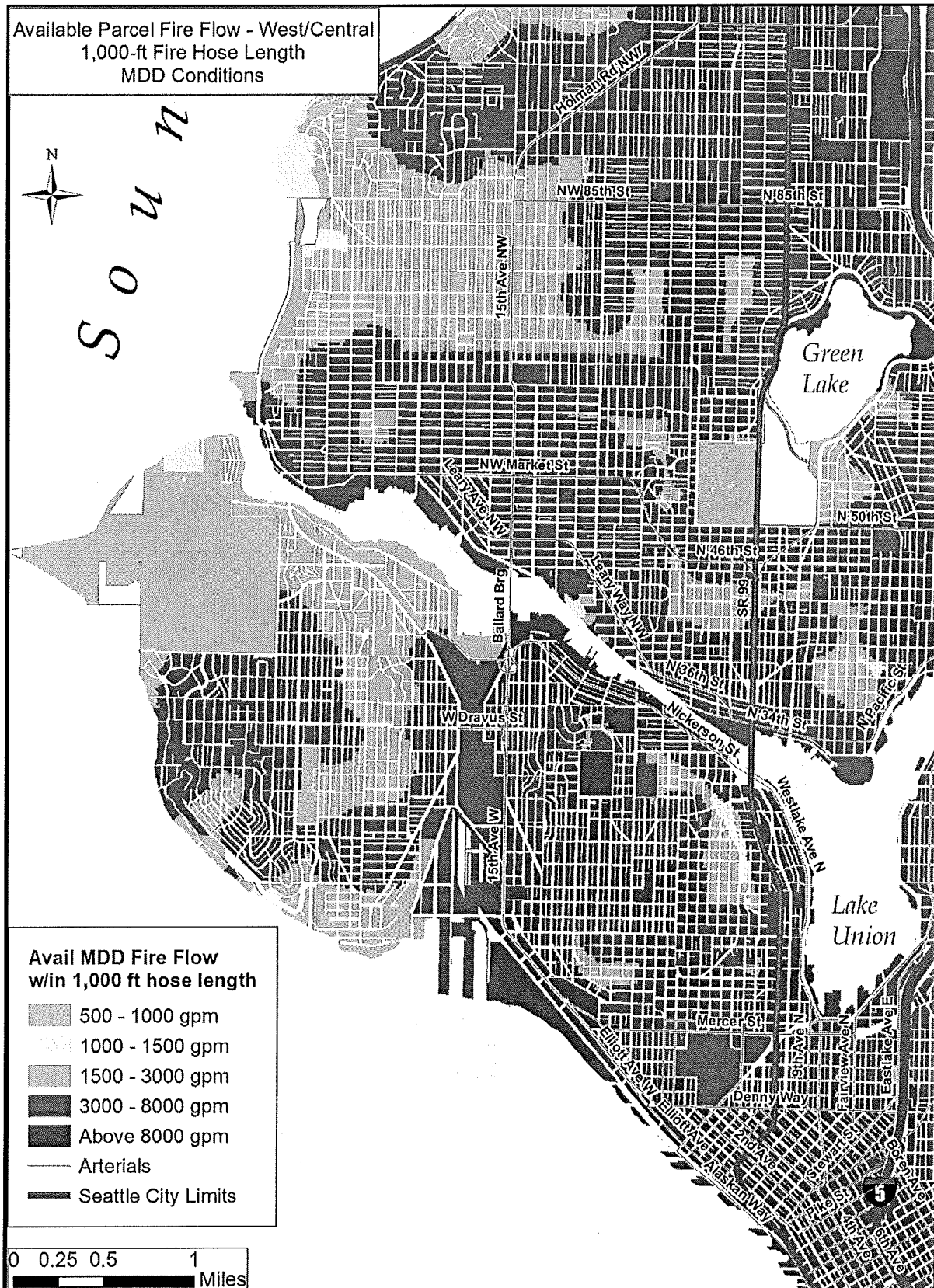
1. Available MDD Fire Flow within a 1,000-foot fire hose length
 - a. Entire direct service area (DSA)
 - b. Northwest DSA
 - c. Northeast DSA
 - d. West/Central DSA
 - e. East/Central DSA
 - f. Southwest DSA
 - g. Southeast DSA

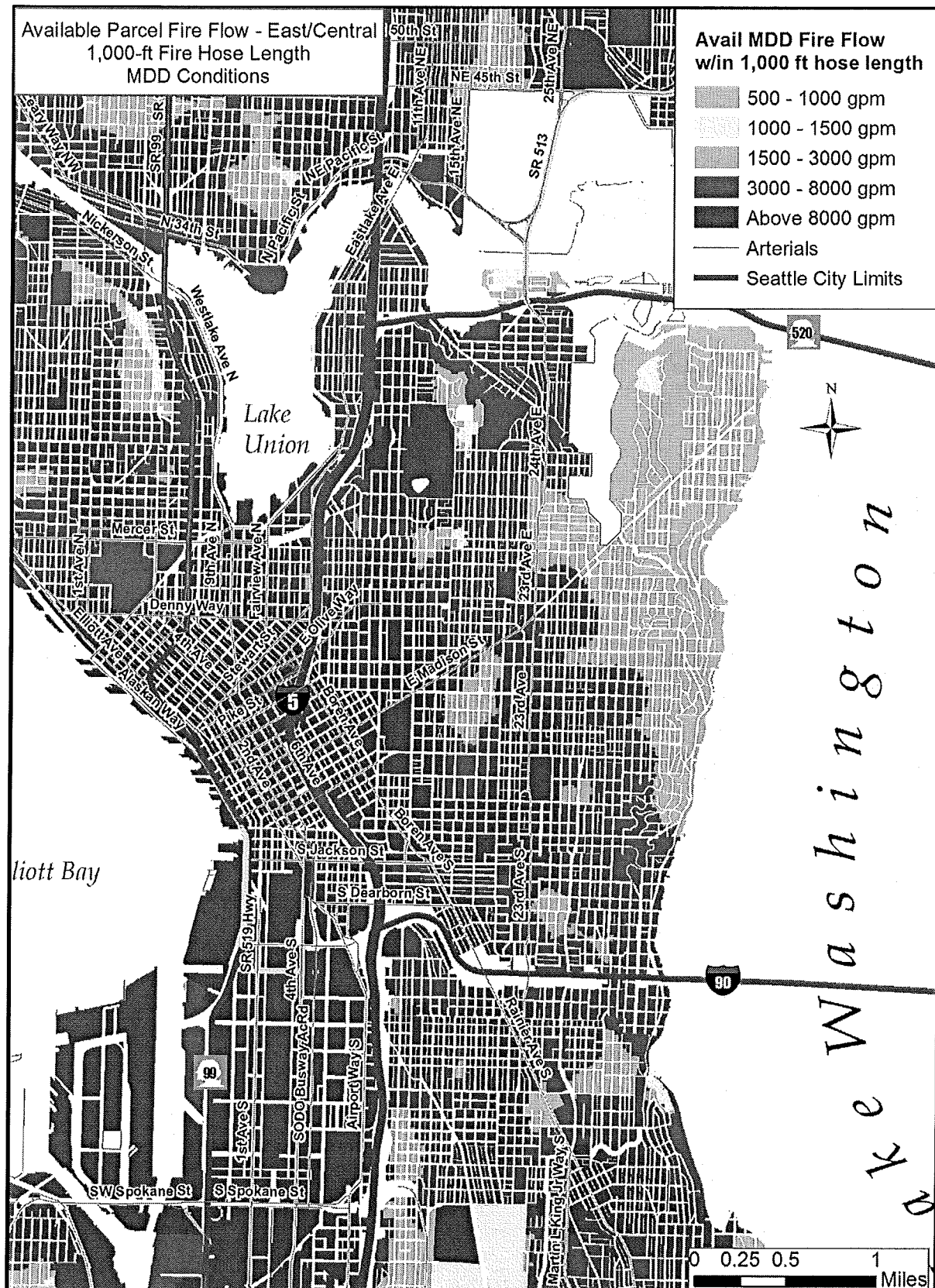
2. Areas not meeting 1,000-gpm/1,000-ft Single Family Fire Flow Operational Performance Target
 - a. Shoreline – Innis Arden
 - b. Blue Ridge
 - c. Montlake
 - d. North Capitol Hill
 - e. Burien – Shorewood
 - f. Burien - Hurstwood

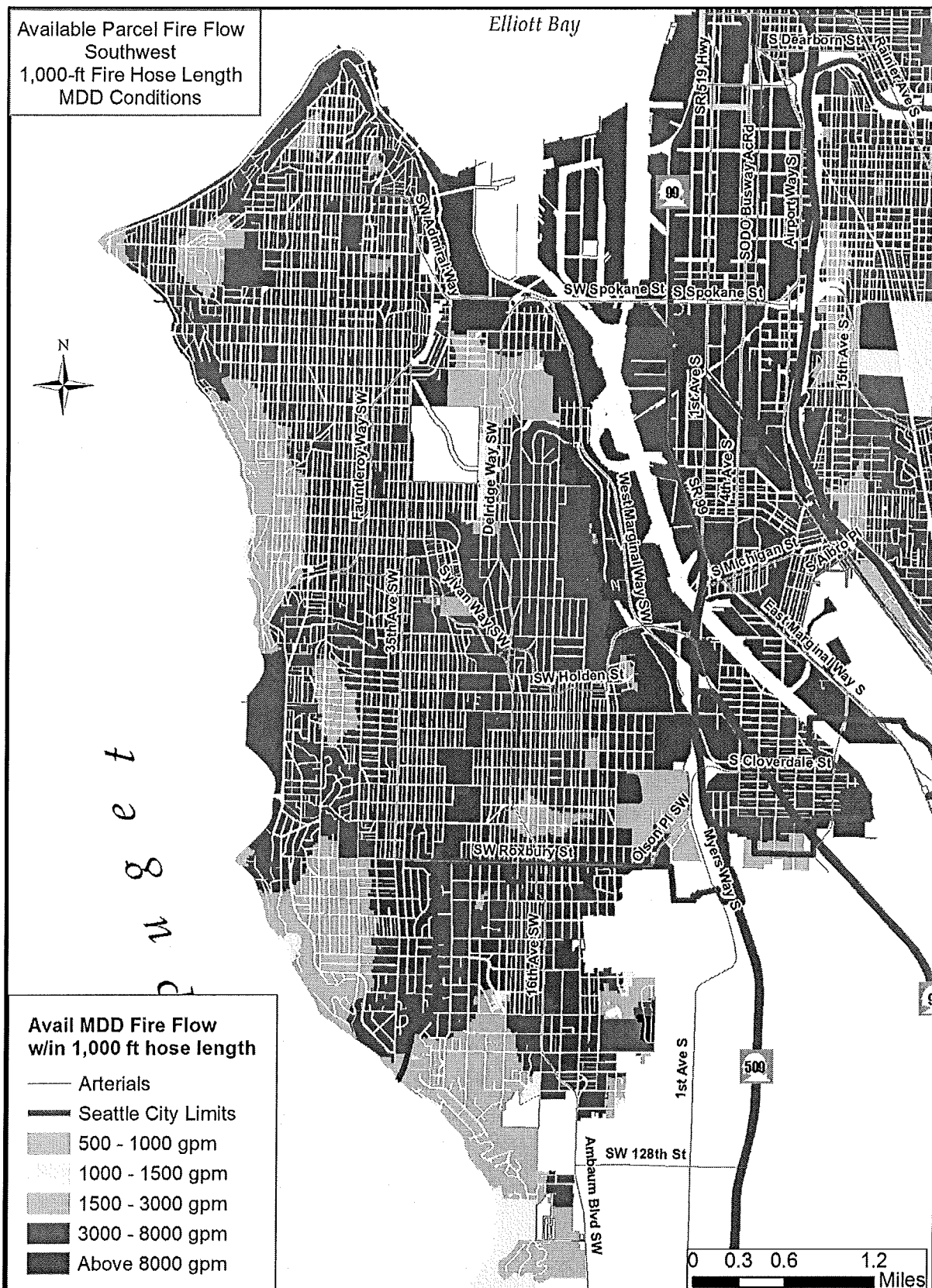


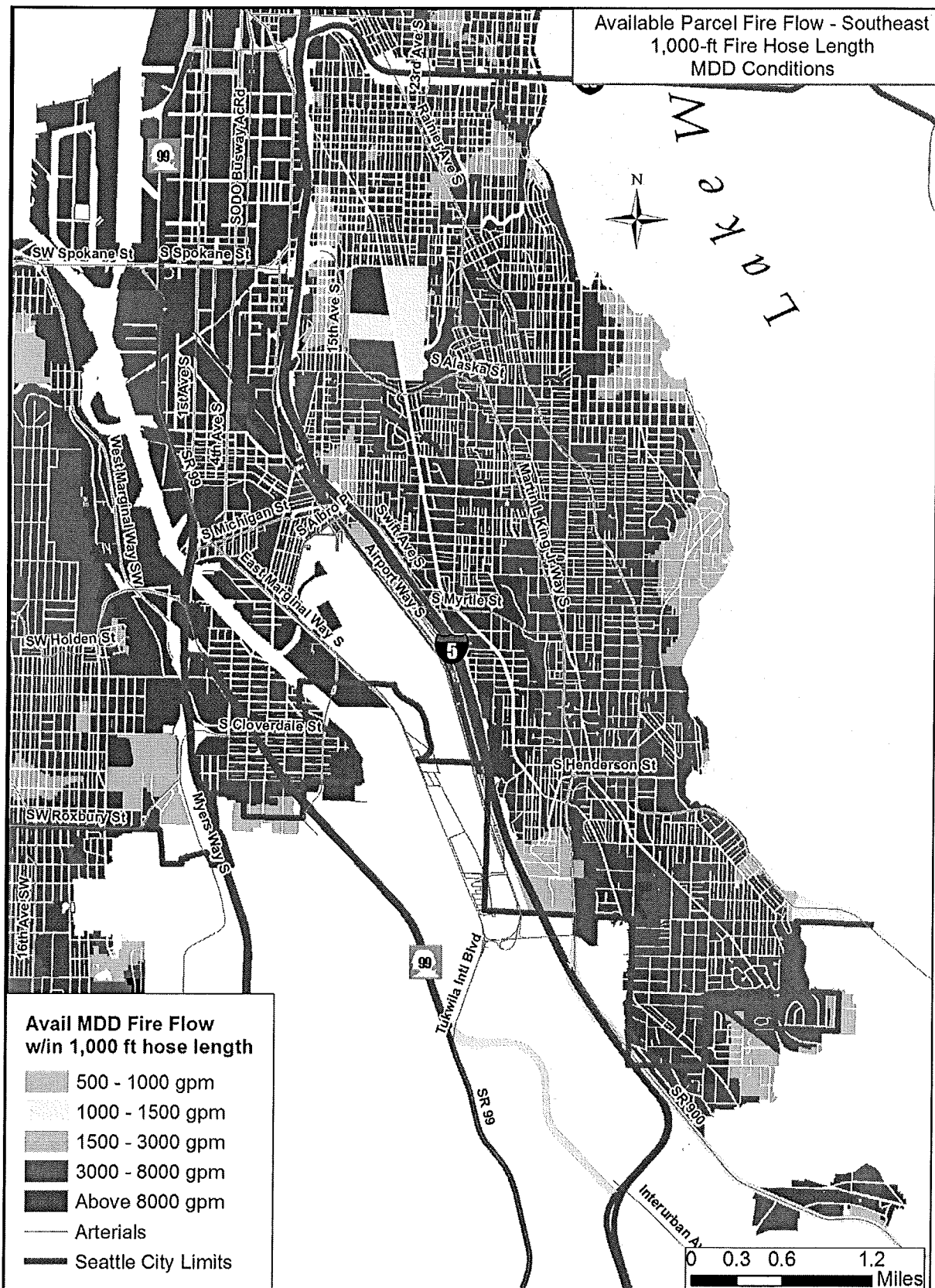


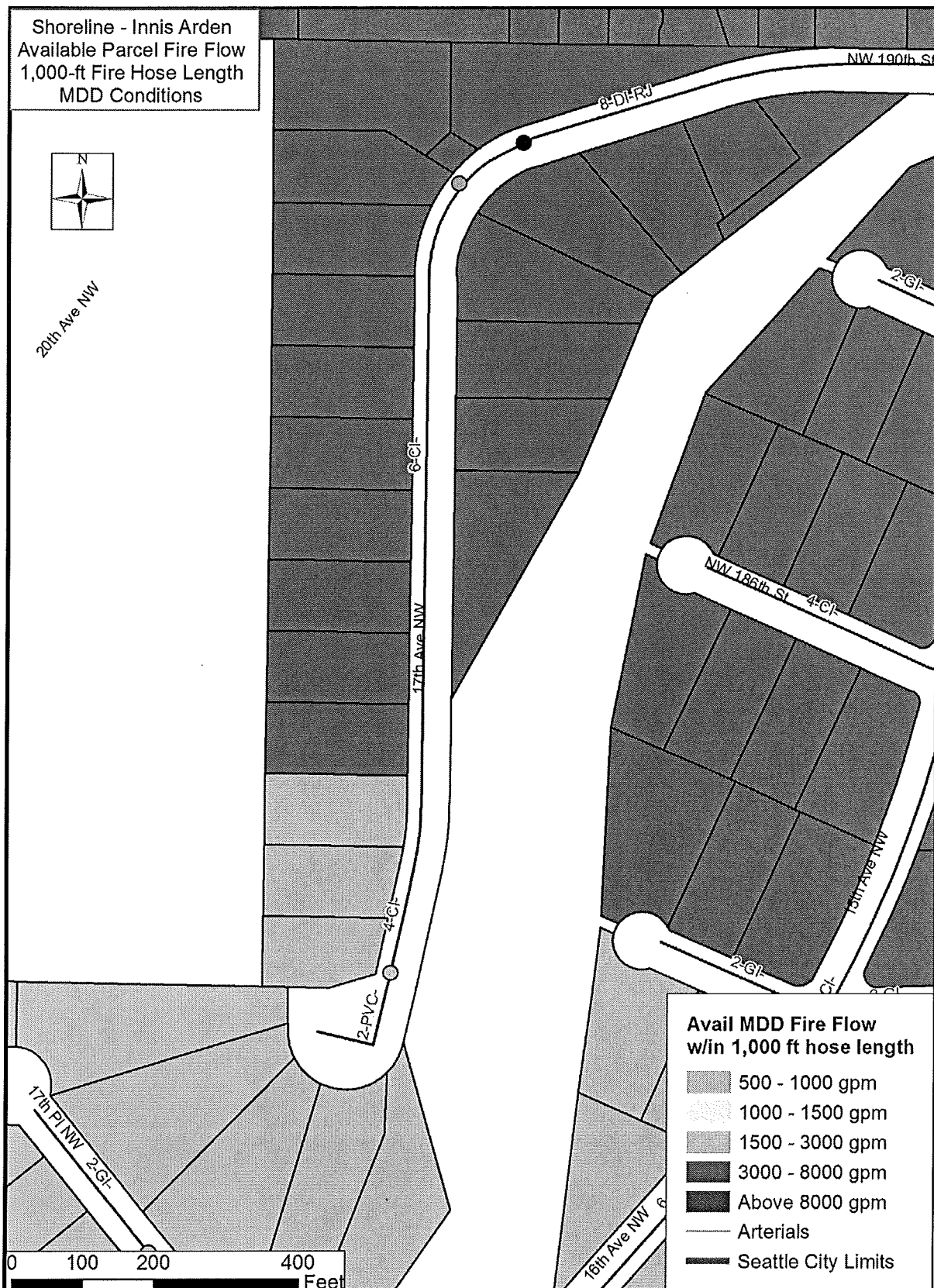


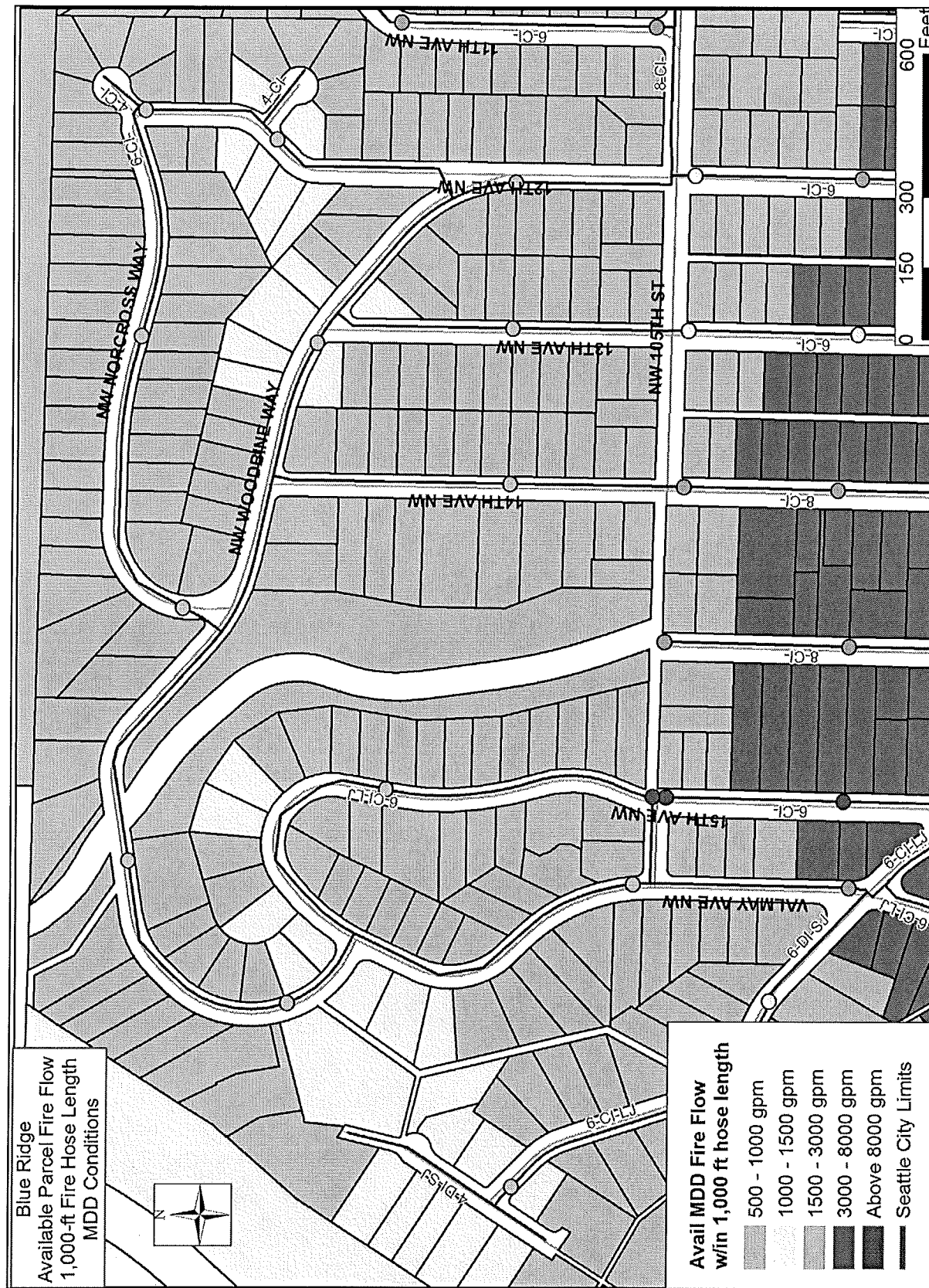


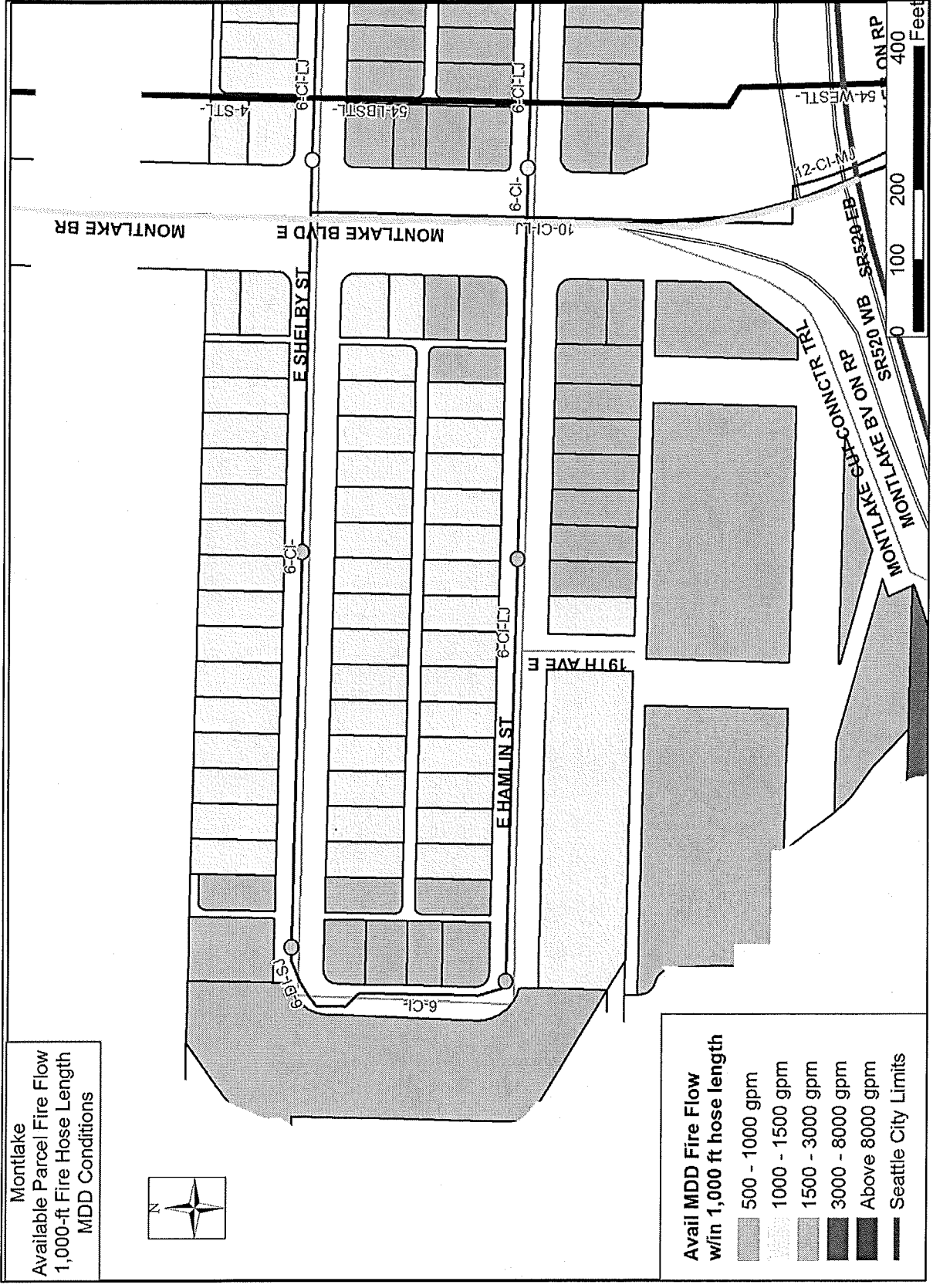


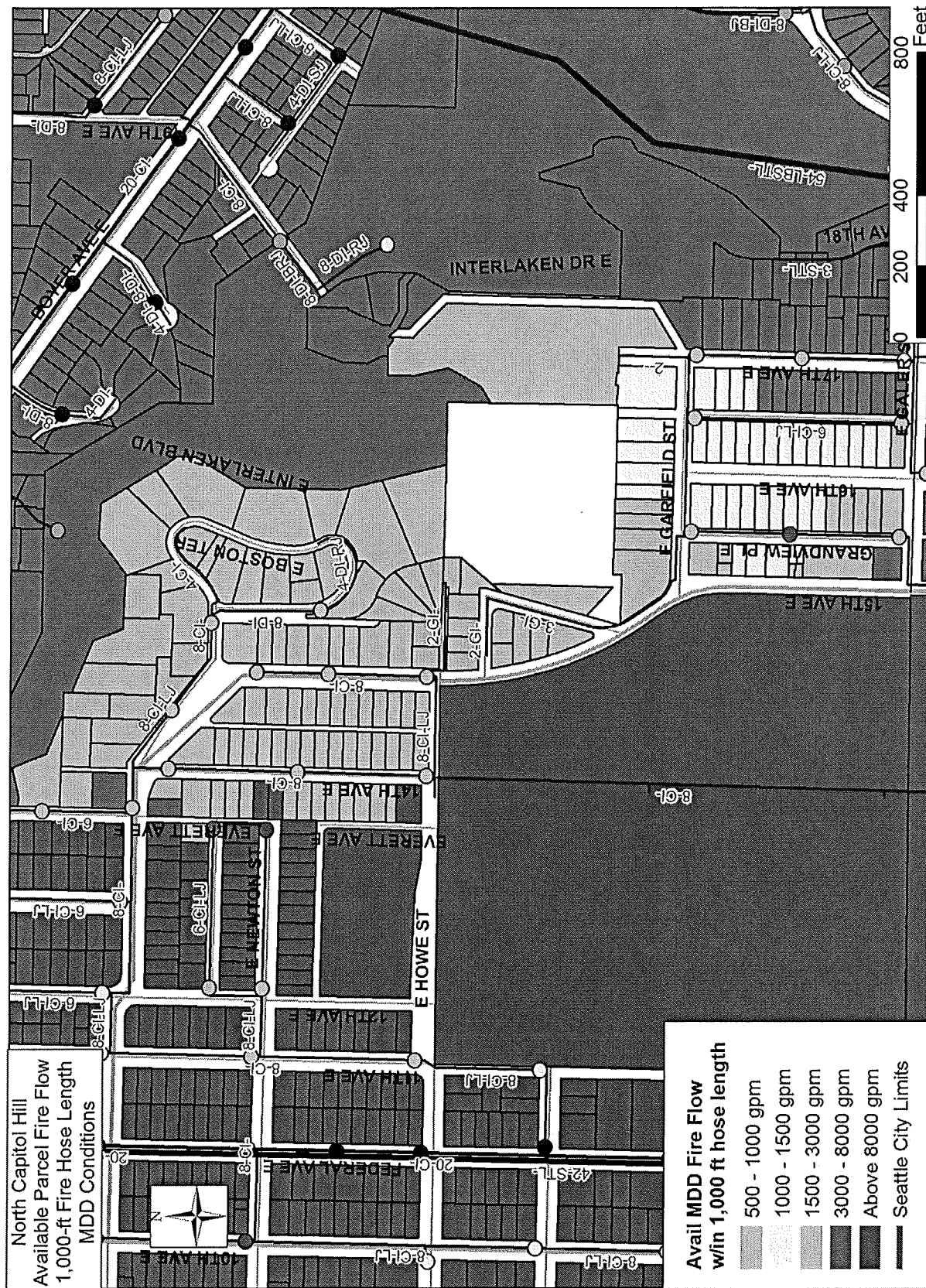




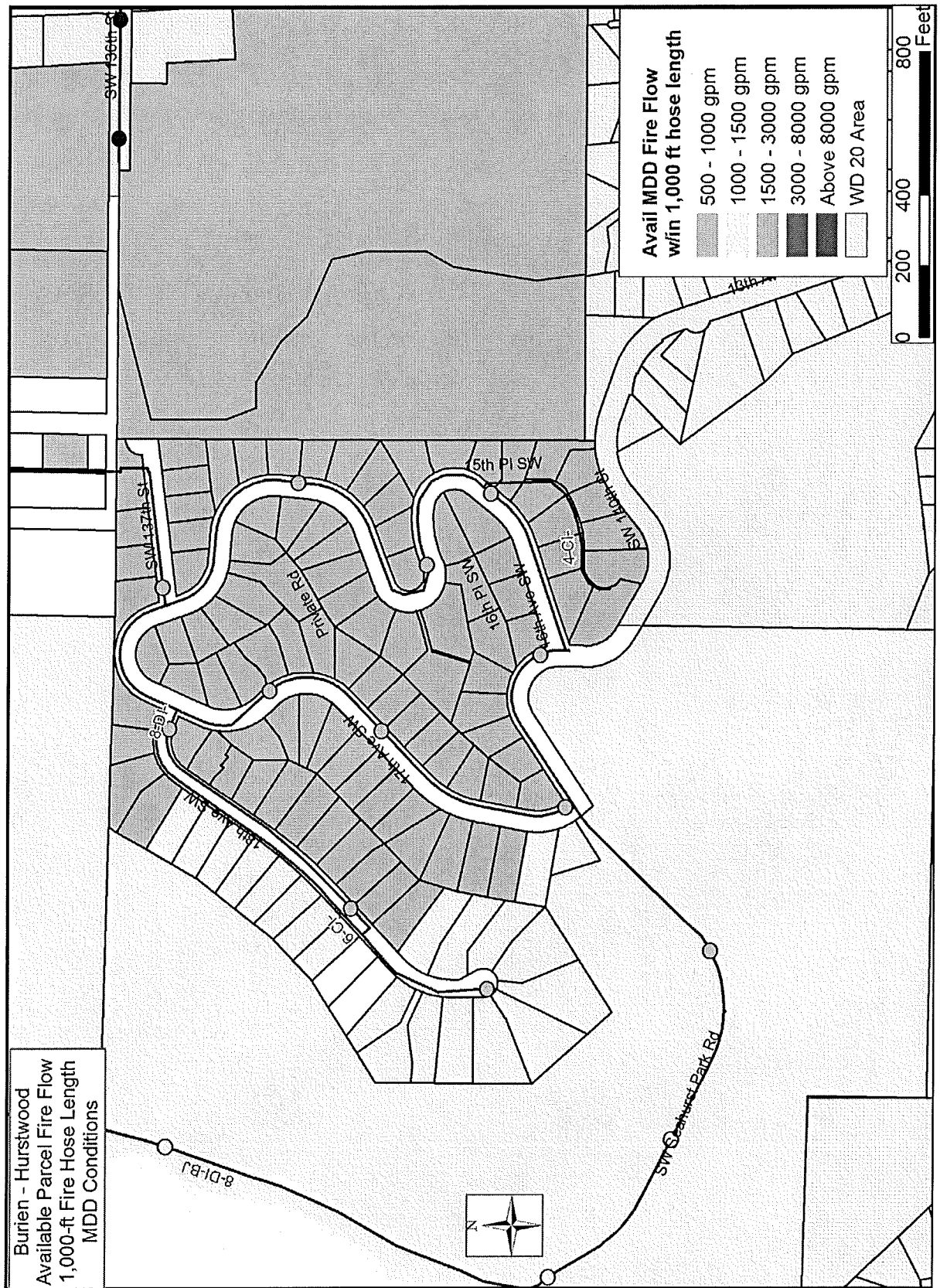












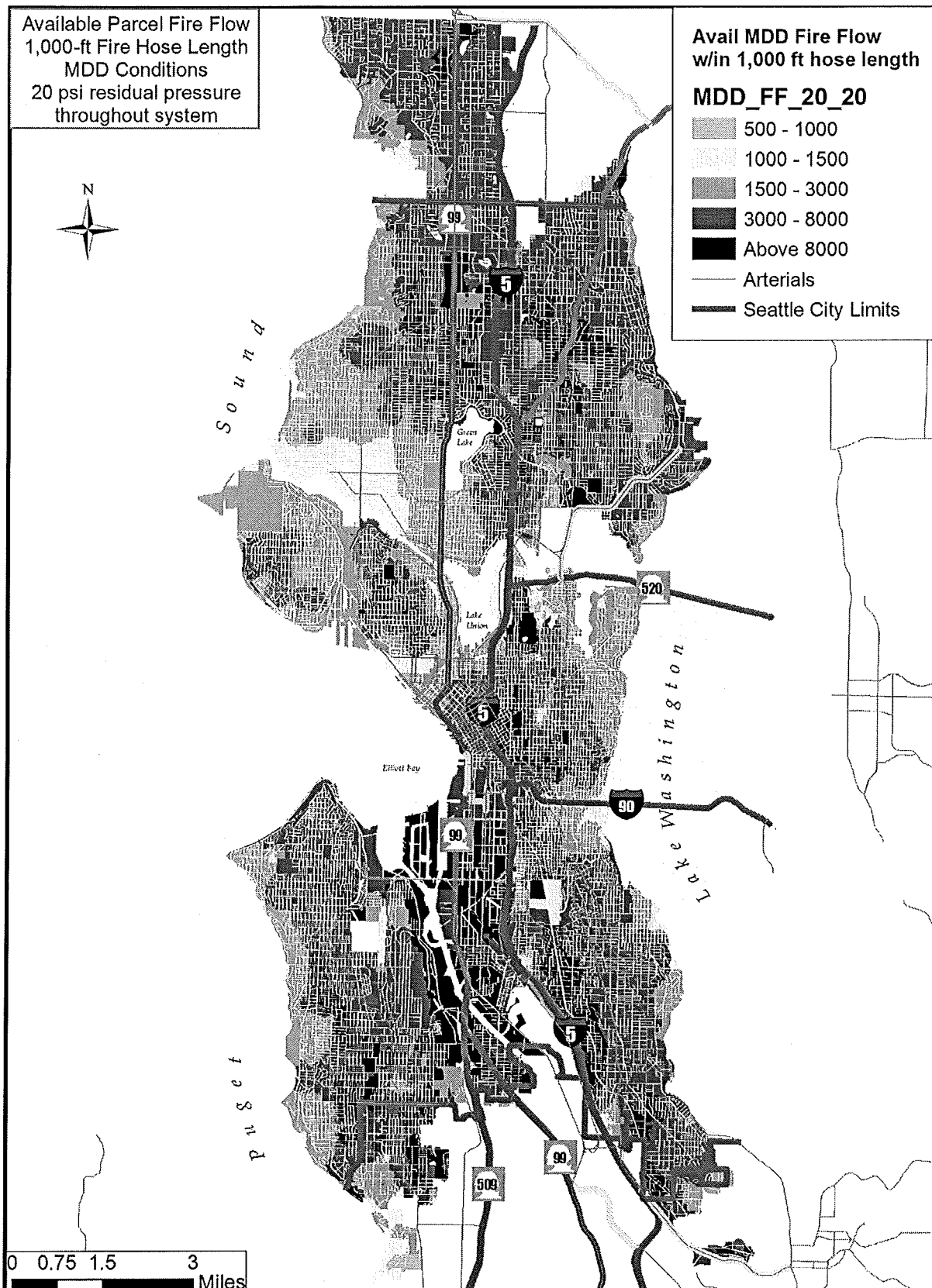
2017 Fire Flow Analysis Maps

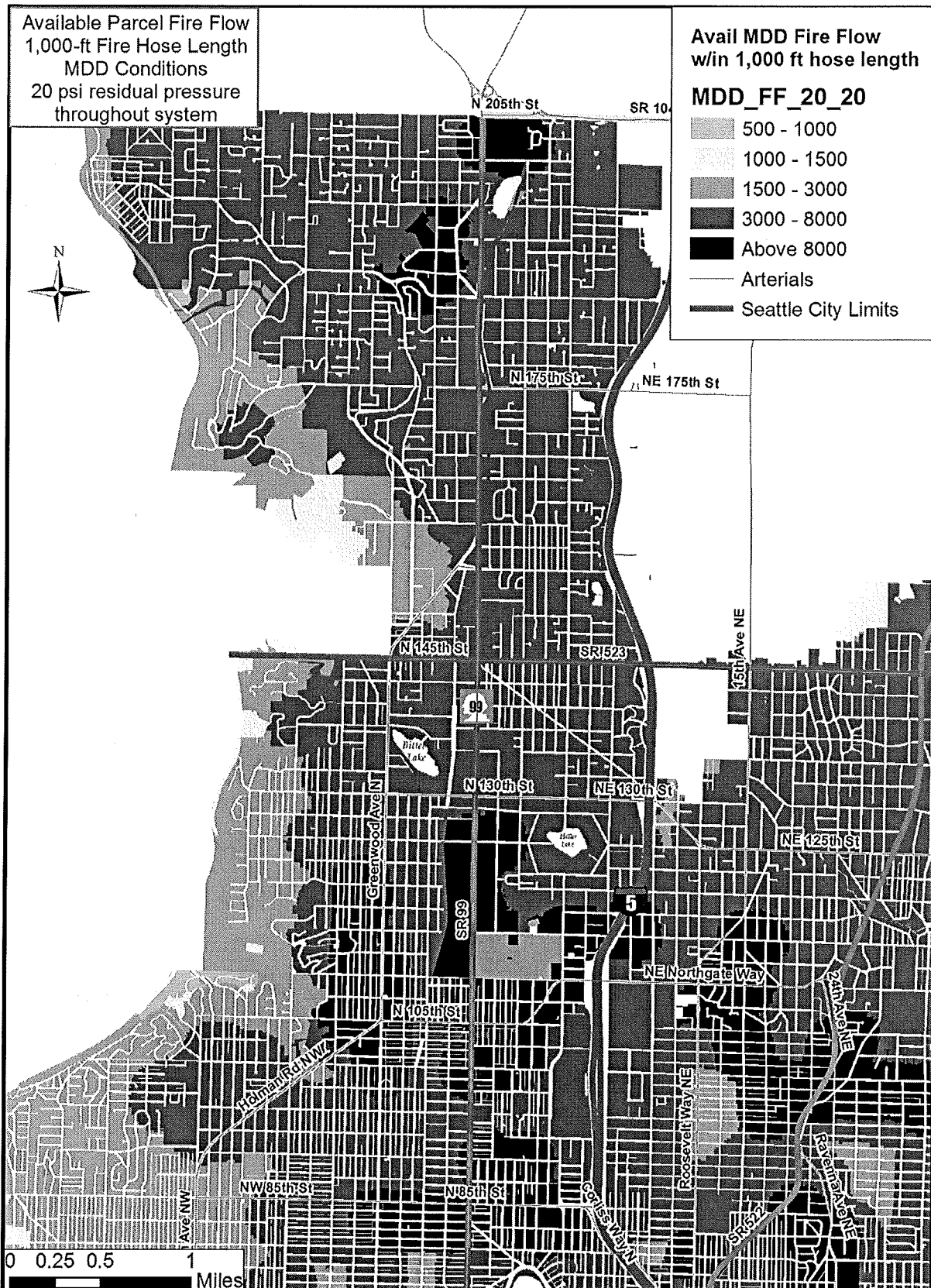
Additional model run at 20 psi residual pressure at test hydrant while maintaining a minimum 20 psi elsewhere in the system

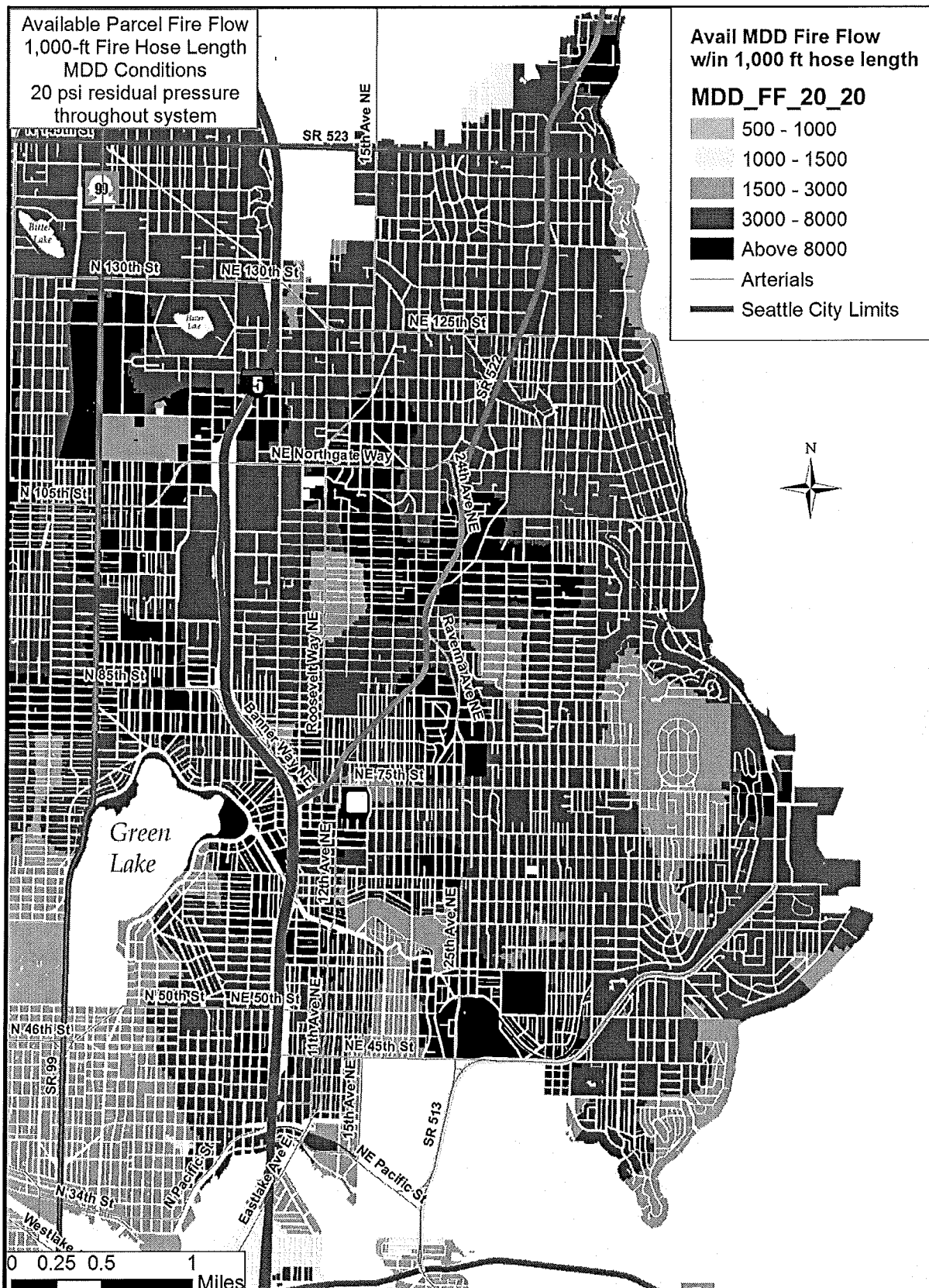
SPU also modeled the system maintaining a minimum 20 psi residual pressure throughout the system. The results of this analysis are shown on the following maps:

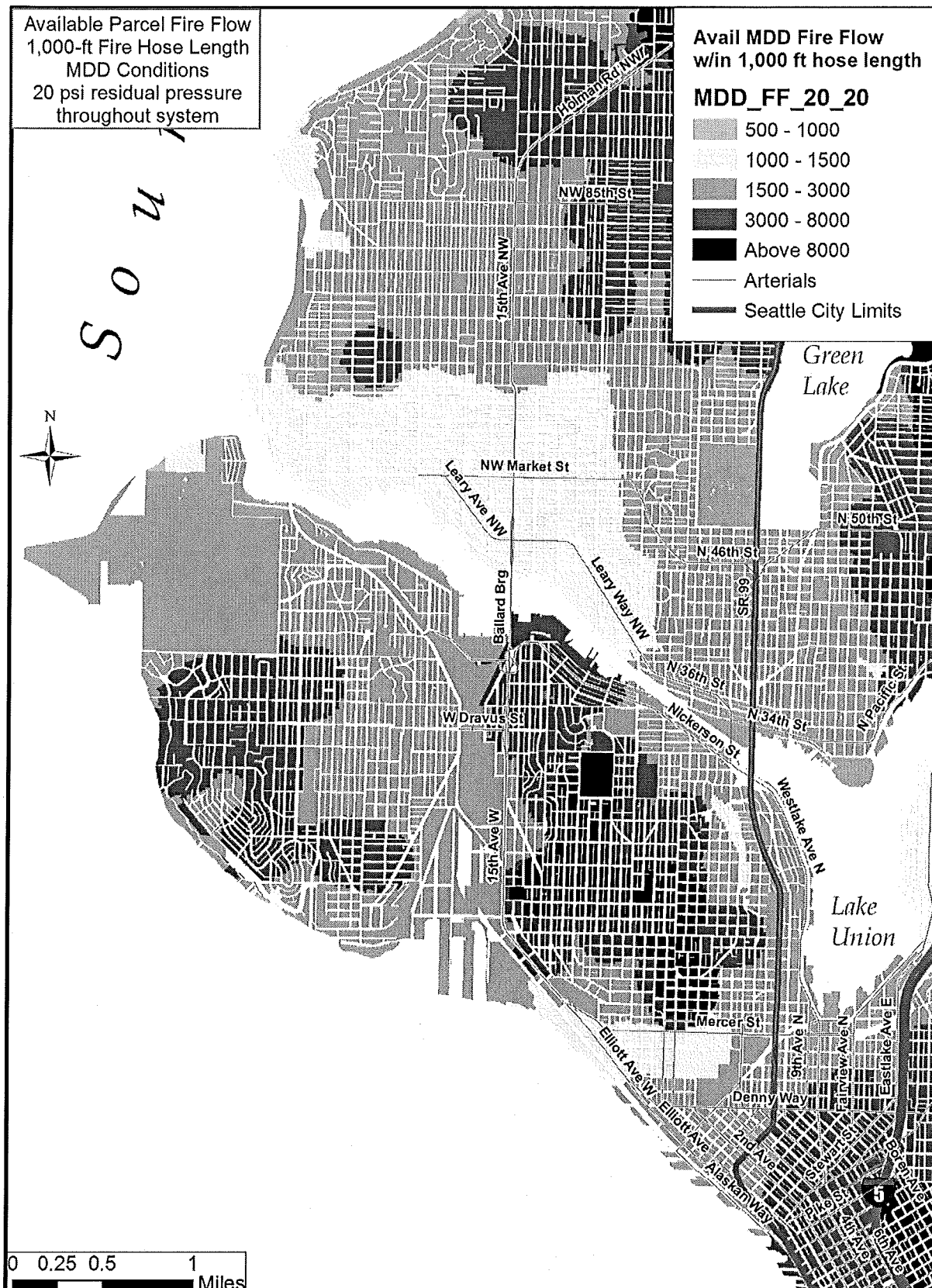
1. Available MDD Fire Flow within a 1,000-foot fire hose length, 20 psi minimum residual pressure maintained throughout system
 - a. Entire direct service area (DSA)
 - b. Northwest DSA
 - c. Northeast DSA
 - d. West/Central DSA
 - e. East/Central DSA
 - f. Southwest DSA
 - g. Southeast DSA

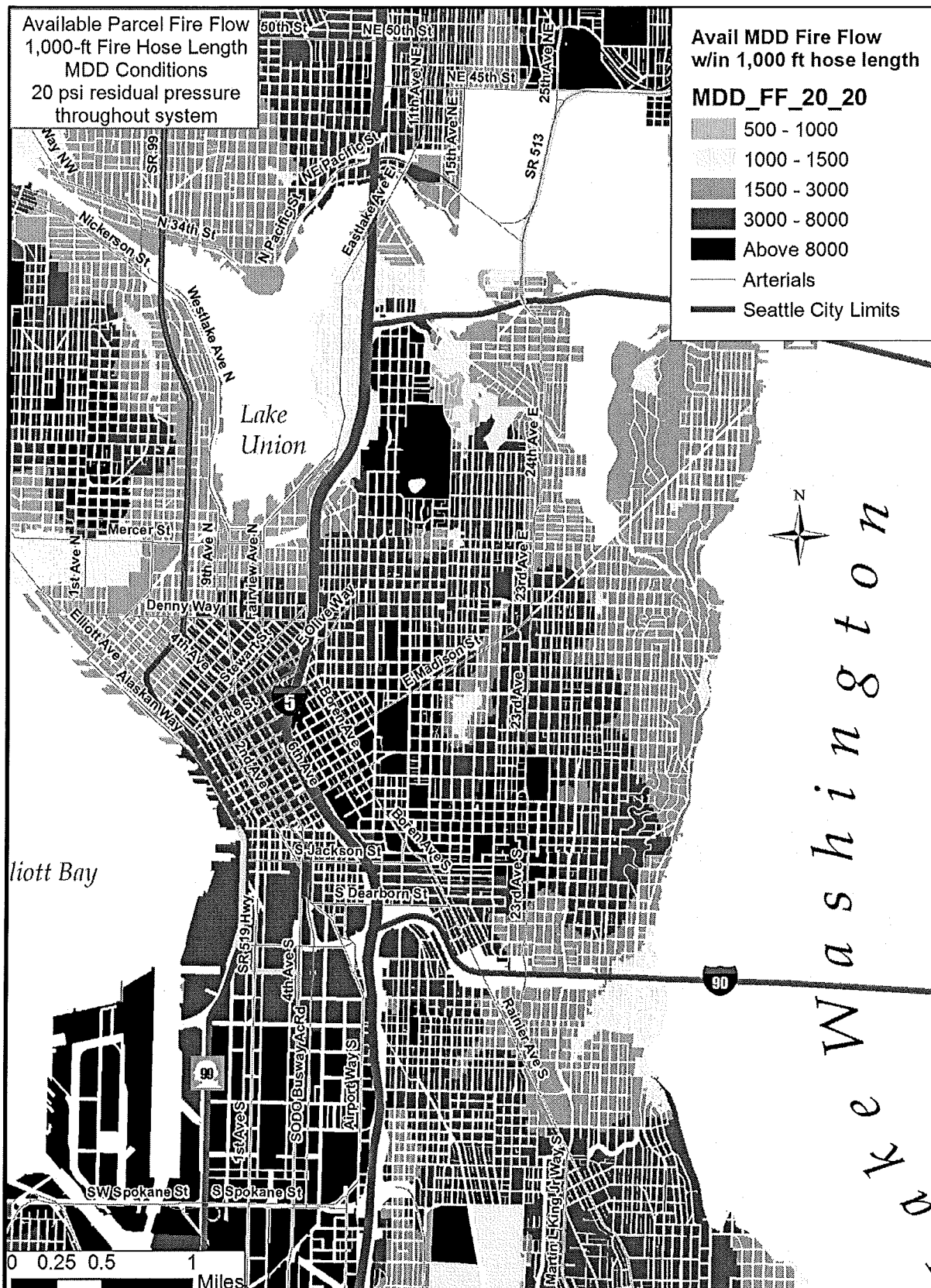
2. Areas with MDD FF restricted by minimum 20 psi residual pressure throughout system
 - a. Ballard 326 Area
 - b. Lower Queen Anne 326 Area
 - c. Eastlake 326 Area

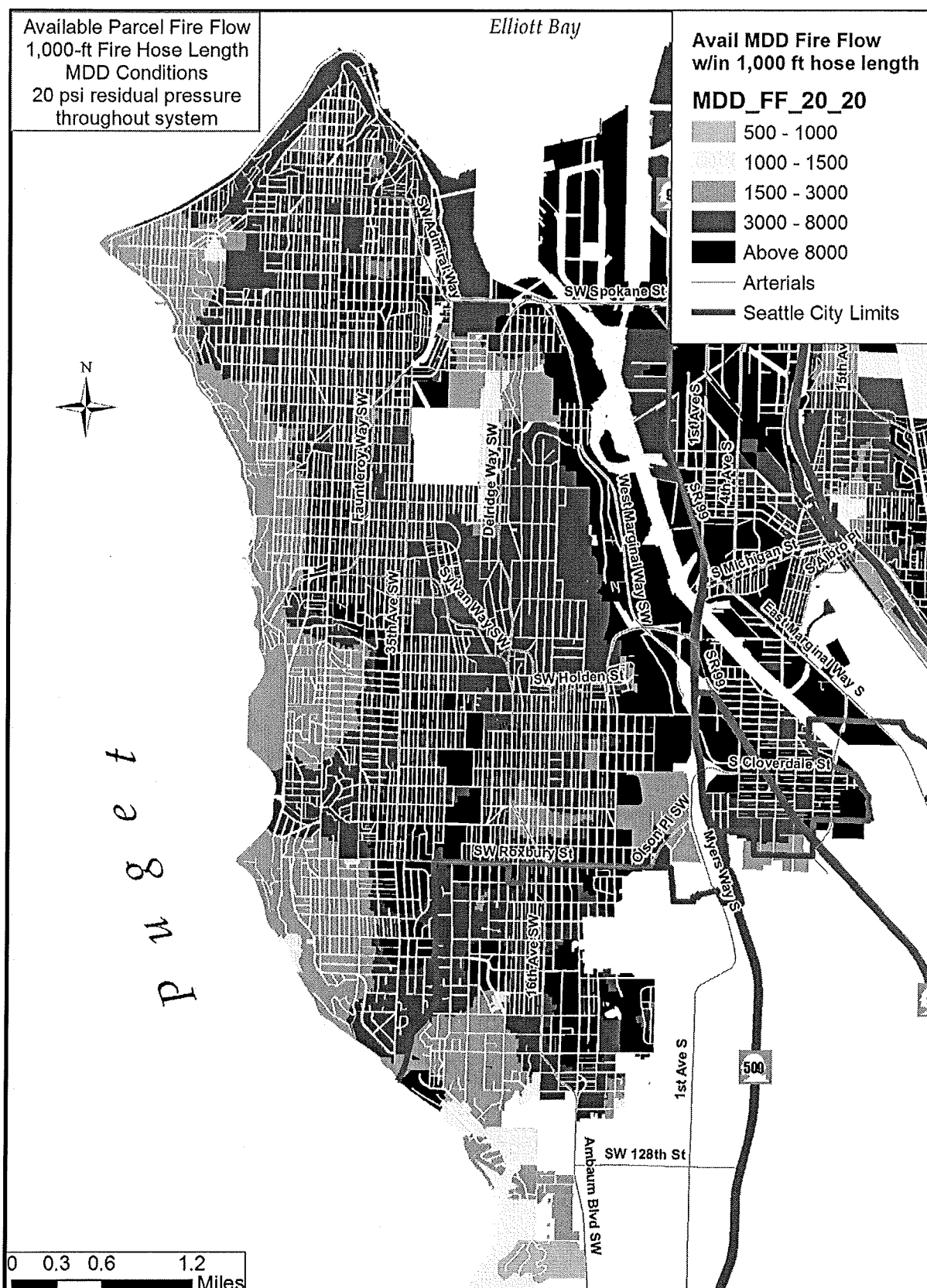


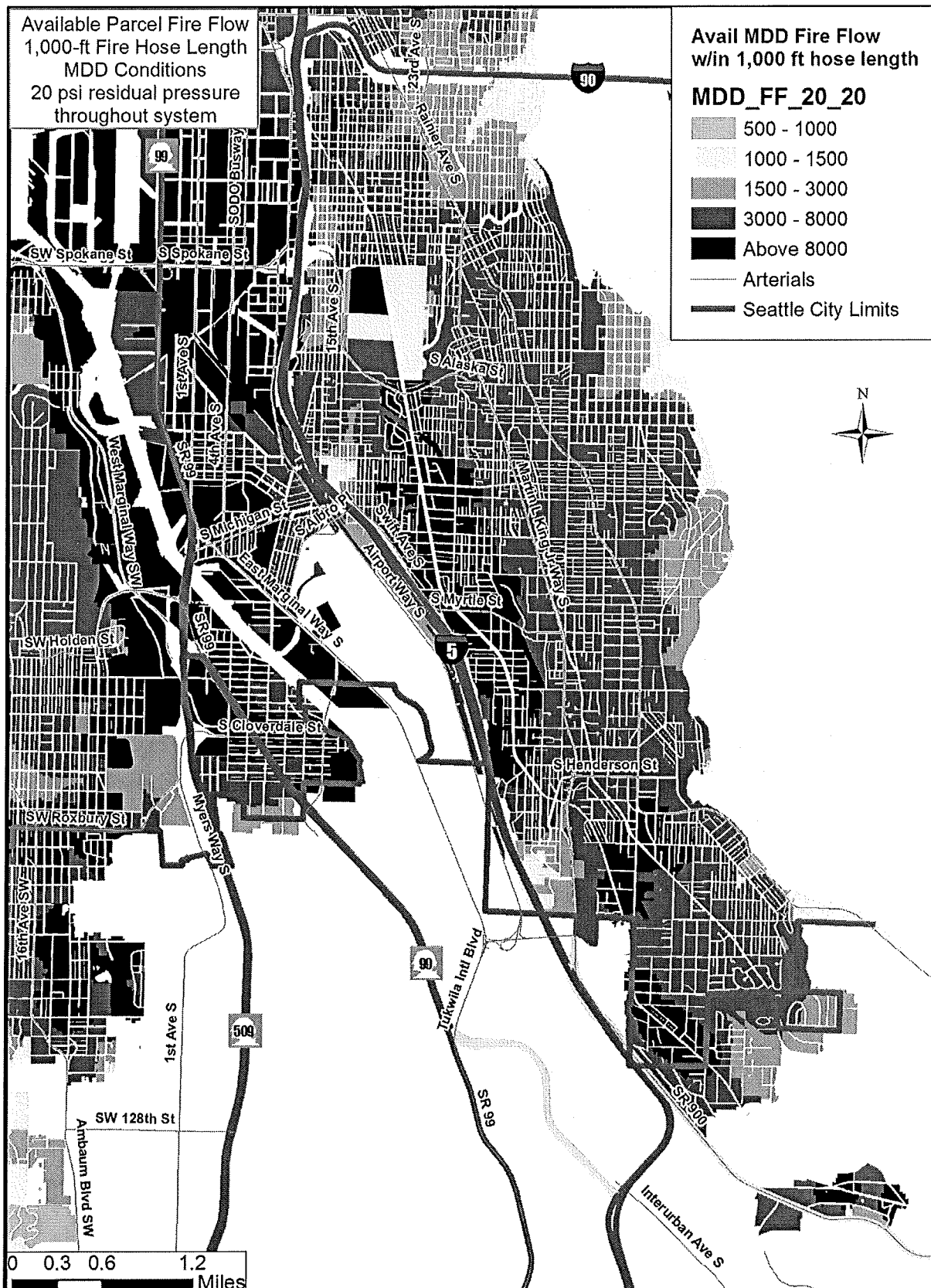




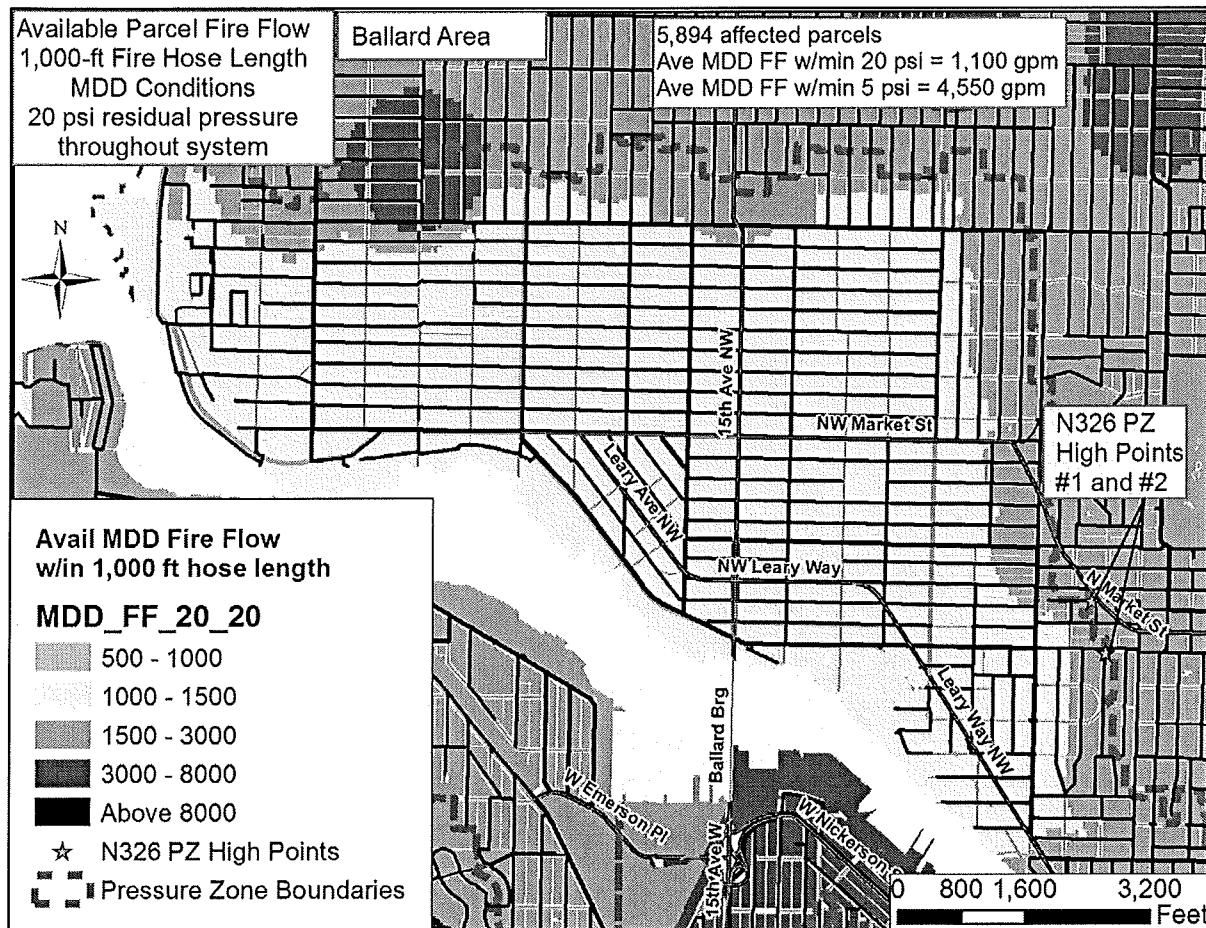








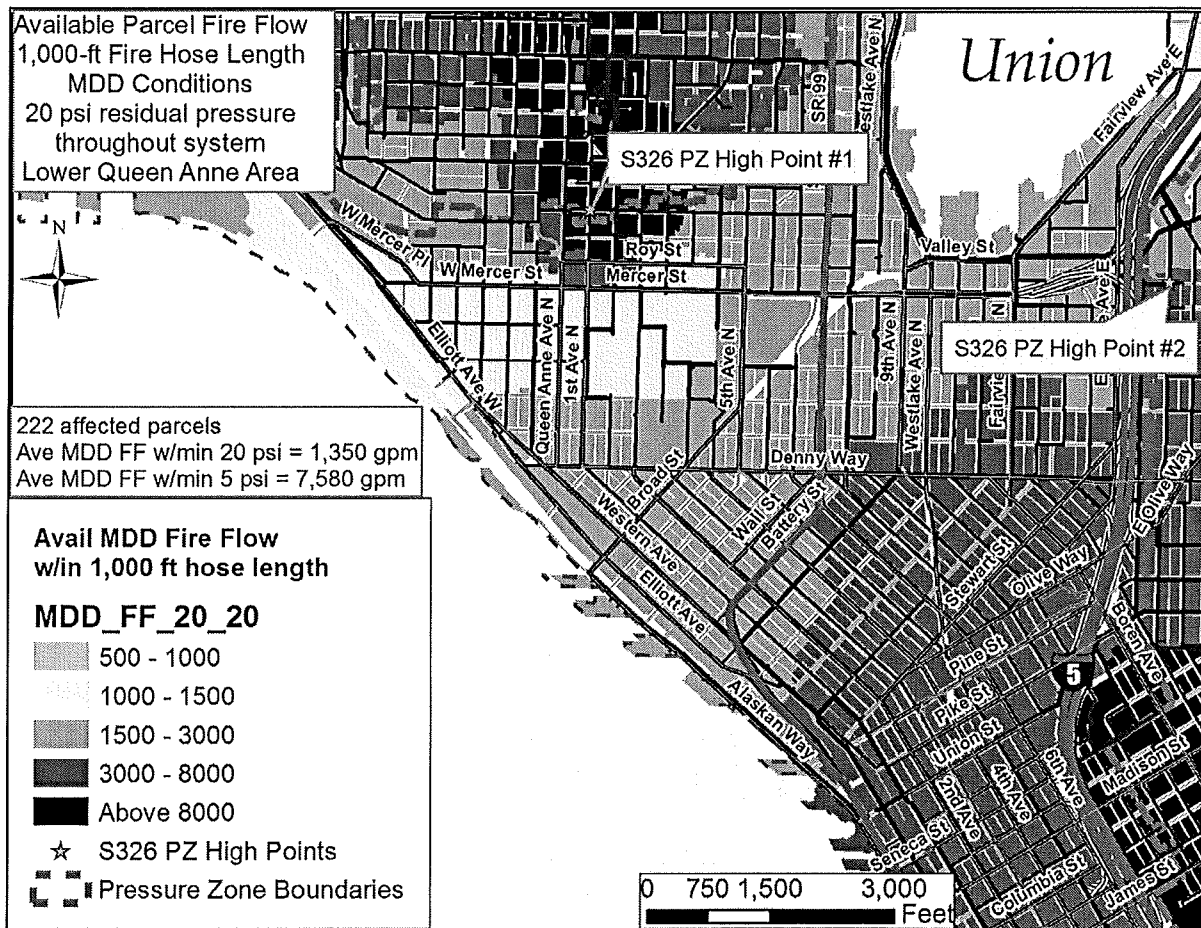
Ballard 326 Area



Ballard 326 Area

Available fire flow in the Ballard 326 area under maximum day demand (MDD) conditions and a 20 psi minimum system residual pressure is controlled by two high-elevation points in the North 326 Pressure Zone. A total of 5,894 parcels are affected. The high-elevation points are located at NW 47th Street and 1st Avenue NW (elevation 242 feet) and 1st Avenue NW and NW 45th Street (elevation 244 feet). Maintaining a minimum 20 psi residual pressure at these locations under MDD conditions restricts average available fire flow in the Ballard 326 area to 1,100 gpm, versus an average available fire flow of 4,550 gpm with 5 psi (positive pressure) maintained at these points.

Lower Queen Anne 326 Area

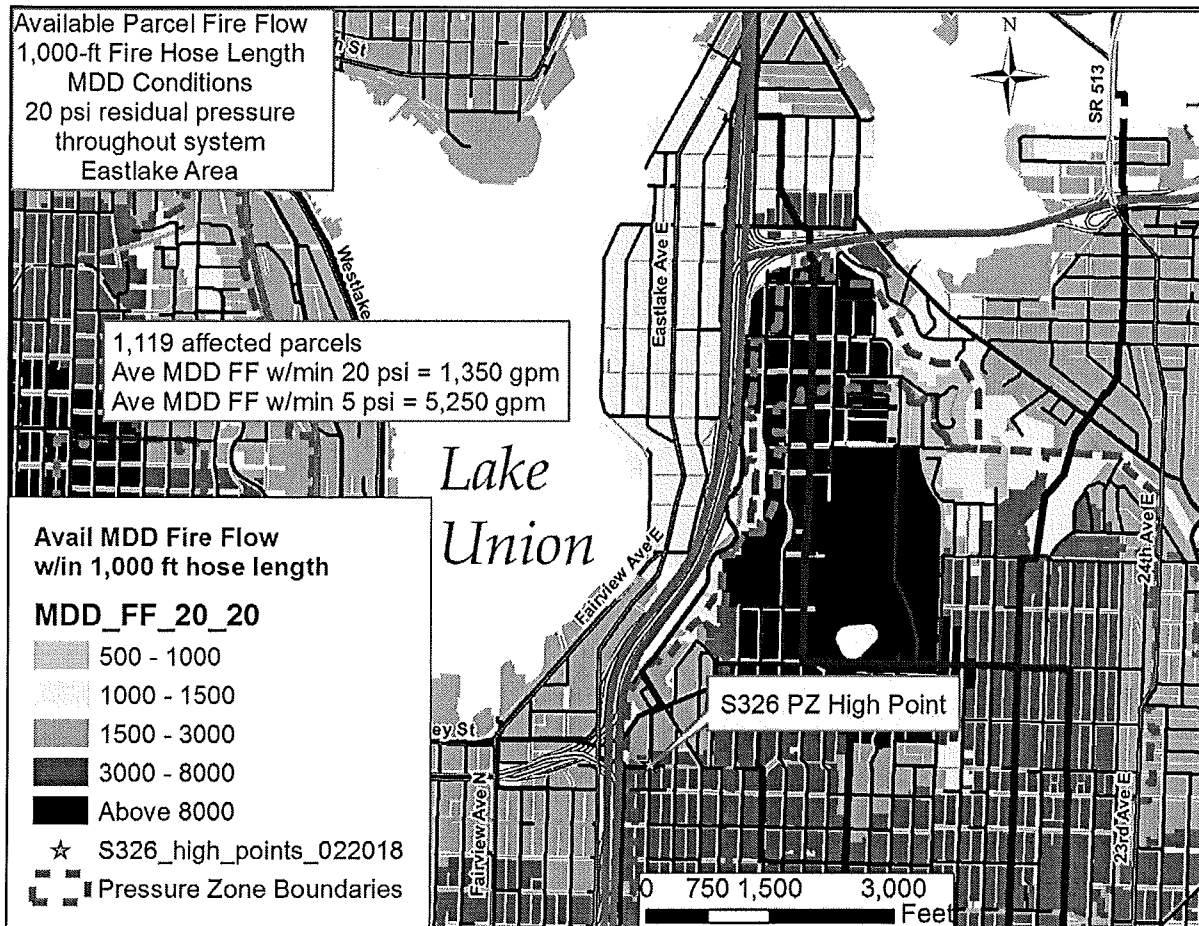


Lower Queen Anne 326 Area

Available fire flow in the Lower Queen Anne 326 area under maximum day demand (MDD) conditions and a 20 psi minimum system residual pressure is controlled by two high-elevation points in the South 326 Pressure Zone. A total of 222 parcels are affected. The high-elevation points are located at 1st Ave N and Aloha St (elevation 248 feet) and Bellevue Ave E and E Roy Street (elevation 252 feet).

Maintaining a minimum 20 psi residual pressure at these locations under MDD conditions restricts average available fire flow in the Lower Queen Anne 326 area to 1,350 gpm, versus an average available fire flow of 7,580 gpm with 5 psi (positive pressure) maintained at these points.

Eastlake 326 Area



Eastlake 326 Area

Available fire flow in the Eastlake 326 area under maximum day demand (MDD) conditions and a 20 psi minimum system residual pressure is controlled by a single high-elevation point in the South 326 Pressure Zone. A total of 1,119 parcels are affected. The high-elevation point is located at Bellevue Avenue E and E Roy Street (elevation 252 feet). Maintaining a minimum 20 psi residual pressure at these locations under MDD conditions restricts average available fire flow in the Eastlake 326 area to 1,350 gpm, versus an average available fire flow of 5,250 gpm with 5 psi (positive pressure) maintained at these points.

There are no South 326 PZ water service connections near the high point at Bellevue Avenue E and E Roy Street. This point is on a 20-inch feeder water main that was relocated higher up the hill to accommodate construction of the I-5 freeway.

The areas not meeting the fire flow performance target (using the 20 psi residual pressure criterion) may be addressed in the following ways:

- Performing more detailed hydraulic model analysis to assess the particular hydraulic conditions associated with fires in specific areas of each pressure zone, also potentially using multiple hydrants.
- Working with the Seattle Fire Marshal to confirm or adjust fire flow (and pressure) requirements in these areas.
- Identified for improvement associated with watermain extension/improvements necessitated by future development. It should be noted that these projects fall under a larger category of future fire flow improvement projects that are developer-financed. Additionally, due to the particular locations of high points in each zone, future development in those high points could be required to connect to adjacent higher pressure zones and/or re-establish new pressure zone boundaries.

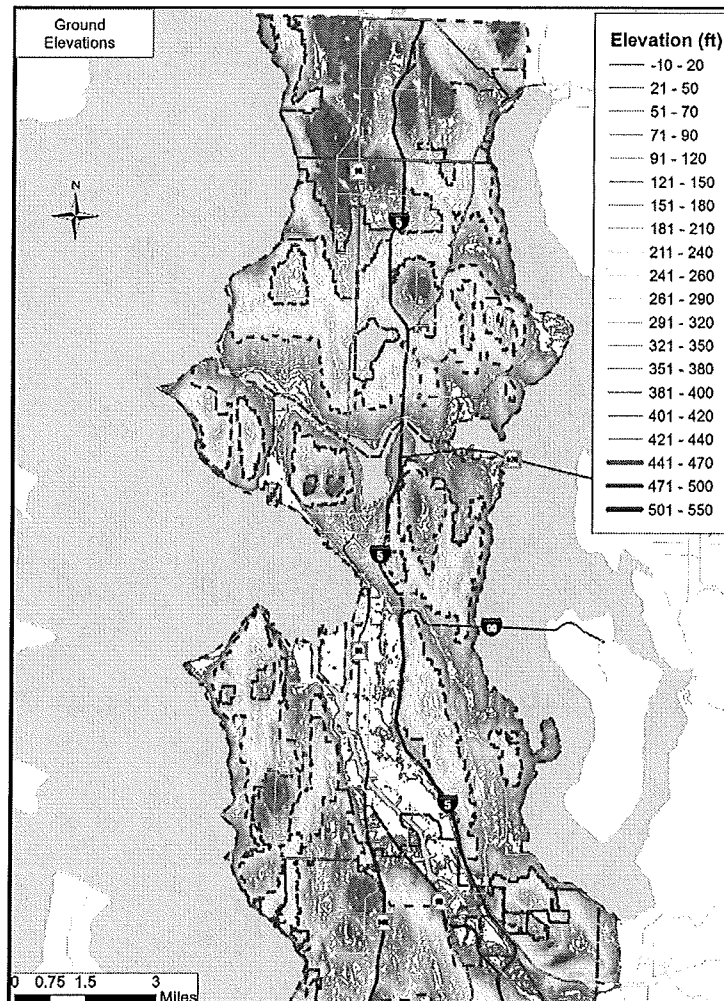
High Pressure Areas

1 INTRODUCTION

This document describes areas with static water pressure greater than 80 pounds per square inch (psi) in the Seattle Public Utilities (SPU) water distribution system.

2 TOPOGRAPHY OF SPU WATER DISTRIBUTION SYSTEM

The SPU Water distribution system serves areas with elevations between 12 and 532 feet (NAVD-88 datum). The SPU system is divided into 11 pressure zones and multiple sub-zones to provide water pressures to customers within an acceptable range. A topographic map of the SPU water distribution system is shown below.



3 SPU POLICY ON HIGH WATER PRESSURE

SPU's policy on high water pressure states the following:

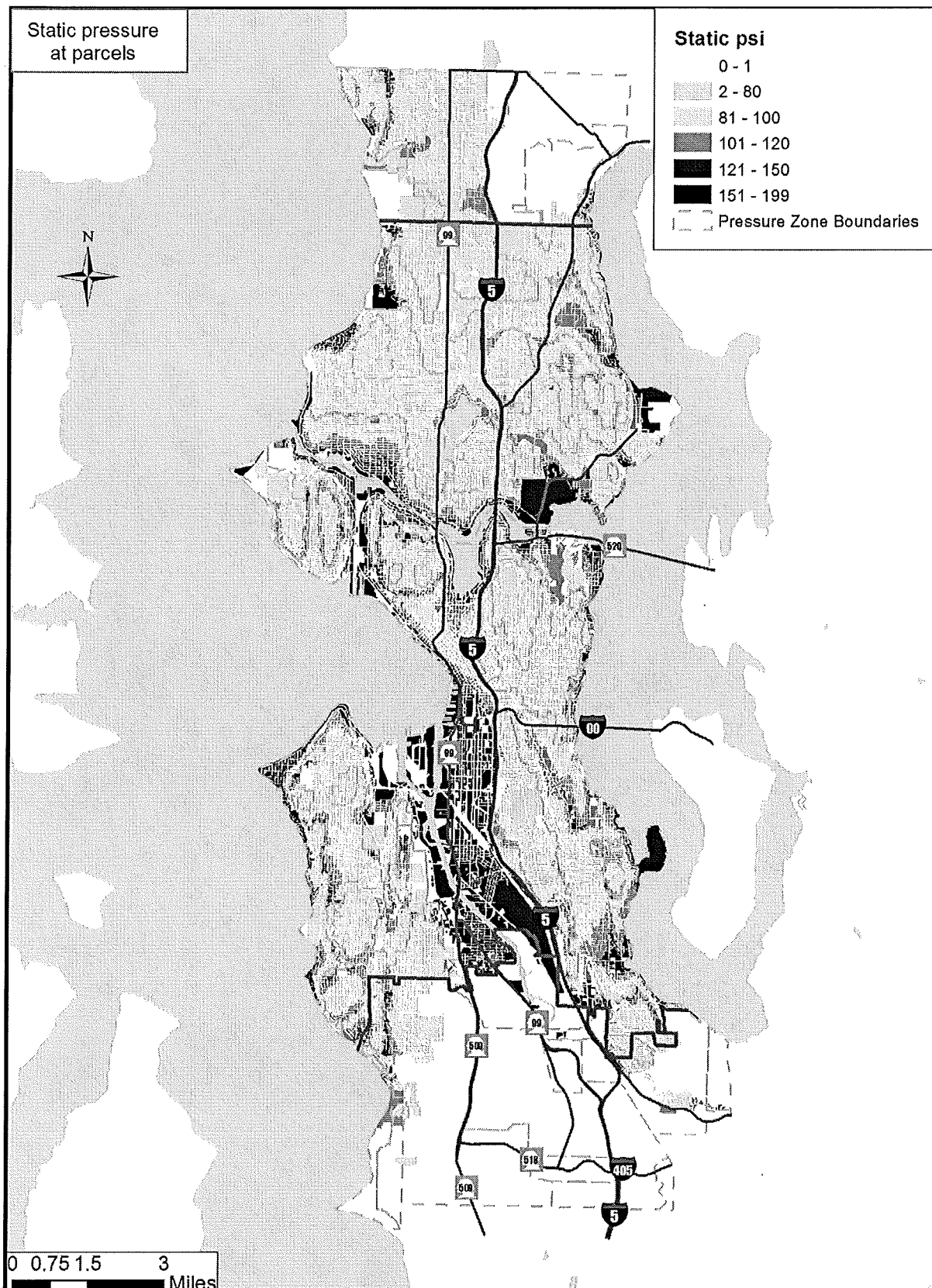
- There is no maximum pressure limit in the SPU distribution system.
- Customers with water pressure greater than 80 psi are advised to follow Uniform Plumbing Code guidelines for installing pressure reducing valves on property.
- Installation of pressure reducing valves on property is the responsibility of customers and at their cost, with the exception of when an SPU-initiated pressure increase of 10 psi or greater raises customer's static water pressure from below 80 psi to at or above 80 psi. In such cases, SPU will reimburse customers for reasonable costs for installation of pressure reducing valves.

4 HIGH WATER PRESSURE ANALYSIS

An analysis of high water pressure in the SPU water distribution system was performed using the following data:

- Nominal static head for SPU water pressure zones (either water storage overflow elevations or nominal pipeline/pump discharge heads).
- Nearest 2-foot elevation contour line to the point of connection of water service lines to water mains.

Static pressure was determined by subtracting the service line elevation from the nominal static head and multiplying the resulting value by 0.433. For display purposes, the static pressure at the service line was assigned to the parcel served by the service line. The high pressure analysis results are shown in the map on the following page.



High Pressure Analysis Summary

Static water pressure is summarized by pressure zone in the table below.

Pressure Zone	Number of Parcels Served	Pressure at Water Main (psi)		
		Minimum	Maximum	Average
Augusta 500/550	701	54	107	77
Barton 484	2,173	29	139	92
Beacon 460	8,175	48	145	87
Bitter Lake 509	7,727	39	157	75
First Hill 530	167	71	113	87
Magnolia 330	3,061	43	136	84
Magnolia 480	4,112	42	194	88
Maple Leaf 430	37,120	25	168	75
Maple Leaf 550	6,458	34	127	81
North 326	21,044	29	134	86
Olympic Hills 510	327	66	101	85
Queen Anne 530	4,997	33	167	88
Richmond Highlands 590	15,268	35	176	71
Skyway 500	2,630	43	142	86
South 326	34,060	31	136	95
Volunteer 430	9,273	29	146	68
Volunteer 530	3,818	33	130	67
West Seattle 498	13,958	31	149	84
West Seattle 585	10,995	30	151	86
Entire System	186,064	25	194	82

- Static water pressures greater than 80 psi are present in nearly every pressure zone in the SPU water distribution system.
- The South 326 pressure zone contains the most widespread areas with static pressure over 80 psi with elevations near Sea Level having static pressures above 120 psi.
- There are approximately 180 parcels with static pressures over 150 psi. Most of these are in the Maple Leaf 430 pressure zone along Puget Sound.
- The parcel with the highest static water pressure is the King County wastewater treatment plant at West Point, which has 194 psi.

SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

D. MISCELLANEOUS

APPENDIX D-2
Capital Facilities Plan

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Seattle Public Utilities - 2019 Water System Plan
Capital Facilities Plan
2017 Dollars (1000s)

Business Area	Project /Program	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Water Resources	Regional Water Conservation	\$1,406	\$1,045	\$1,045	\$1,045	\$1,045	\$1,045	\$1,045	\$1,045	\$1,045	\$1,045	\$1,045	\$0	\$0
	Seattle Low Income Conservation Program	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697
	Water Supply Resiliency	\$0	\$0	\$0	\$0	\$0	\$0	\$168	\$410	\$5,605	\$78	\$0	\$0	\$0
	Dam Safety	\$798	\$224	\$511	\$1,074	\$1,083	\$1,832	\$673	\$821	\$4,404	\$4,297	\$381	\$372	\$363
Water Resources Total		\$2,901	\$1,966	\$2,253	\$2,816	\$2,825	\$3,575	\$2,584	\$2,974	\$11,752	\$6,117	\$2,124	\$1,069	\$1,060
Water Quality and Treatment	Reservoir Upgrades/Improvements	\$2,061	\$5,584	\$18,582	\$1,666	\$6,620	\$16,901	\$8,497	\$821	\$801	\$781	\$3,811	\$3,718	\$725
	Water Quality & Treatment Improvements	\$244	\$238	\$446	\$136	\$133	\$0	\$0	\$0	\$0	\$0	\$2,972	\$0	\$3,990
Water Quality and Treatment Total		\$2,305	\$5,822	\$19,028	\$1,802	\$6,753	\$16,901	\$8,497	\$821	\$801	\$781	\$6,783	\$3,718	\$4,715
Transmission	Tank Improvements	\$409	\$1,396	\$3,052	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	Water System Dewatering	\$26	\$29	\$31	\$32	\$32	\$34	\$34	\$34	\$34	\$34	\$34	\$34	\$34
	Purveyor Meter Replacements	\$208	\$207	\$207	\$91	\$88	\$86	\$86	\$86	\$86	\$86	\$86	\$86	\$86
	Transmission Pipelines Upgrades	\$7,139	\$8,409	\$6,291	\$8,833	\$2,652	\$1,725	\$1,773	\$4,150	\$7,555	\$5,067	\$7,894	\$1,844	\$1,946
	Seismic Upgrades - Transmission	\$0	\$0	\$232	\$226	\$442	\$431	\$1,750	\$7,250	\$7,250	\$7,250	\$7,250	\$11,250	\$11,250
	Cathodic Protection	\$1,929	\$2,010	\$572	\$2,102	\$552	\$2,094	\$538	\$2,043	\$1,333	\$5,060	\$1,301	\$4,936	\$1,269
	Replace Air Valve Chambers	\$124	\$124	\$123	\$118	\$115	\$112	\$123	\$123	\$123	\$123	\$123	\$123	\$123
Transmission Total		\$9,835	\$12,176	\$10,508	\$11,401	\$3,880	\$4,482	\$4,305	\$13,686	\$16,382	\$17,620	\$16,688	\$18,274	\$14,709
Distribution	Service Renewals	\$5,694	\$4,715	\$4,710	\$4,705	\$4,699	\$4,694	\$4,694	\$4,488	\$4,288	\$4,093	\$3,902	\$3,717	\$3,535
	Hydrant Replacement/Relocation	\$211	\$210	\$209	\$208	\$207	\$206	\$206	\$206	\$206	\$206	\$206	\$206	\$206
	Water Main Extensions	\$841	\$837	\$833	\$829	\$793	\$789	\$690	\$690	\$690	\$690	\$690	\$690	\$690
	New Hydrants	\$13	\$13	\$13	\$12	\$13	\$13	\$13	\$13	\$13	\$13	\$13	\$13	\$13
	New Taps	\$8,800	\$8,757	\$8,715	\$8,672	\$8,630	\$8,588	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730
	Distribution System Improvements	\$502	\$504	\$501	\$498	\$504	\$500	\$496	\$501	\$496	\$500	\$503	\$498	\$501
	Seismic Upgrades - Distribution	\$1,455	\$3,621	\$3,457	\$3,385	\$3,314	\$3,677	\$7,188	\$8,438	\$8,438	\$8,808	\$8,808	\$8,808	\$9,256
	Water Main Rehabilitation	\$12,109	\$4,481	\$3,218	\$3,238	\$3,252	\$3,704	\$24,995	\$24,986	\$24,977	\$24,968	\$24,958	\$24,949	\$24,901
	Multiple Utility Relocations	\$493	\$476	\$464	\$453	\$442	\$431	\$431	\$431	\$431	\$431	\$431	\$431	\$431
	Tank Improvements	\$302	\$1,218	\$2,043	\$725	\$1,821	\$3,665	\$2,675	\$2,667	\$1,882	\$344	\$267	\$1,502	\$3,250
	Pump Station Improvements	\$1,561	\$1,428	\$260	\$453	\$442	\$431	\$421	\$421	\$421	\$421	\$421	\$421	\$421
	In-Line Gate Valve Improvements	\$336	\$335	\$333	\$331	\$330	\$328	\$421	\$421	\$421	\$421	\$421	\$421	\$421
	Air Valve Chamber Upgrades	\$28	\$28	\$28	\$28	\$27	\$328	\$28	\$28	\$28	\$28	\$28	\$28	\$28
	Distribution System Modifications	\$112	\$103	\$103	\$102	\$102	\$101	\$101	\$101	\$101	\$101	\$101	\$101	\$101
	Meter Replacements/AMR	\$586	\$579	\$571	\$472	\$470	\$467	\$564	\$564	\$564	\$564	\$564	\$564	\$564
	Transportation-Related Projects	\$32,931	\$28,896	\$23,155	\$11,231	\$8,078	\$7,867	\$9,002	\$9,004	\$9,000	\$8,999	\$9,001	\$8,997	\$9,002
Distribution Total		\$65,974	\$56,201	\$48,612	\$35,341	\$33,122	\$35,790	\$58,654	\$59,689	\$58,686	\$57,316	\$57,043	\$58,074	\$60,049
Major Watersheds	Watershed Roads and Bridges	\$954	\$80	\$153	\$95	\$57	\$65	\$766	\$111	\$281	\$252	\$19	\$818	\$725
	Hatchery and Fish Ladder Improvements	\$5,151	\$12,892	\$743	\$226	\$221	\$431	\$0	\$0	\$0	\$0	\$762	\$0	\$0
	Habitat Conservation Program	\$1,912	\$1,758	\$1,343	\$1,363	\$1,231	\$1,133	\$705	\$778	\$612	\$270	\$341	\$209	\$209
Major Watersheds Total		\$8,016	\$14,730	\$2,239	\$1,684	\$1,509	\$1,629	\$1,471	\$889	\$893	\$521	\$1,122	\$1,027	\$935
Other*	Water System Plans	\$293	\$48	\$0	\$0	\$0	\$0	\$0	\$0	\$155	\$522	\$321	\$58	\$0
	In-Town Facilities	\$5,707	\$5,856	\$4,599	\$4,890	\$1,667	\$830	\$9,632	\$10,547	\$8,288	\$6,211	\$5,792	\$2,491	\$2,249
	Regional Facilities	\$5,316	\$705	\$2,020	\$3,986	\$1,724	\$1,897	\$7,361	\$6,566	\$4,644	\$3,672	\$3,392	\$892	\$1,596
	Integrated Control/Monitoring Program	\$351	\$343	\$334	\$326	\$318	\$310	\$310	\$310	\$310	\$310	\$310	\$310	\$310
	Security Improvements	\$866	\$1,356	\$1,207	\$849	\$829	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121
	Heavy Equipment Purchases	\$3,858	\$1,904	\$1,857	\$1,907	\$1,856	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811
	1% for Arts	\$167	\$232	\$337	\$201	\$156	\$251	\$251	\$251	\$251	\$251	\$251	\$251	\$251
	Technology	\$6,859	\$5,220	\$3,907	\$3,842	\$3,749	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657
Other* Total		\$23,418	\$15,664	\$14,262	\$16,002	\$10,298	\$9,878	\$24,144	\$24,263	\$20,238	\$17,555	\$16,655	\$10,592	\$10,995
GRAND TOTAL		\$112,449	\$106,558	\$96,902	\$69,047	\$58,387	\$72,254	\$99,654	\$102,321	\$108,751	\$99,910	\$100,416	\$92,753	\$92,463

* Other includes Water System Plans, Facilities, SCADA, Security, Heavy Equipment, 1% for Arts and Technology

2018 shown for completeness

Seattle Public Utilities - 2019 Water System Plan
Capital Facilities Plan
2017 Dollars (1000s)

Business Area	Project /Program	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2019-2028 Total	2019-2040 Total
Water Resources	Regional Water Conservation	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,455	\$10,455
	Seattle Low Income Conservation Program	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$697	\$6,970	\$15,335
	Water Supply Resiliency	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$6,262	\$6,262
	Dam Safety	\$354	\$345	\$337	\$329	\$321	\$313	\$305	\$298	\$290	\$283	\$15,299	\$19,208
	Water Resources Total	\$1,051	\$1,042	\$1,034	\$1,026	\$1,018	\$1,010	\$1,002	\$995	\$987	\$980	\$38,986	\$51,259
Water Quality and Treatment	Reservoir Upgrades/Improvements	\$708	\$690	\$674	\$657	\$641	\$626	\$610	\$595	\$581	\$567	\$64,063	\$74,856
	Water Quality & Treatment Improvements	\$2,477	\$967	\$2,627	\$2,366	\$1,282	\$2,502	\$0	\$0	\$0	\$0	\$3,925	\$20,136
Water Quality and Treatment Total		\$3,185	\$1,657	\$3,301	\$3,023	\$1,923	\$3,128	\$610	\$595	\$581	\$567	\$67,988	\$94,991
Transmission	Tank Improvements	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$4,448	\$4,448
	Water System Dewatering	\$34	\$34	\$34	\$34	\$34	\$34	\$34	\$34	\$34	\$34	\$330	\$744
	Purveyor Meter Replacements	\$86	\$86	\$86	\$86	\$86	\$86	\$86	\$86	\$86	\$86	\$1,111	\$2,146
	Transmission Pipelines Upgrades	\$5,193	\$9,096	\$1,940	\$1,793	\$4,294	\$7,292	\$1,794	\$1,293	\$1,293	\$1,293	\$54,347	\$93,419
	Seismic Upgrades - Transmission	\$11,250	\$11,250	\$11,250	\$11,250	\$11,250	\$11,250	\$11,250	\$12,250	\$12,250	\$12,250	\$32,082	\$170,082
	Cathodic Protection	\$4,816	\$1,238	\$4,699	\$1,208	\$4,584	\$1,178	\$4,472	\$1,150	\$4,363	\$1,122	\$17,604	\$52,638
	Replace Air Valve Chambers	\$123	\$123	\$123	\$123	\$123	\$123	\$123	\$123	\$123	\$123	\$1,208	\$2,686
	Transmission Total	\$21,503	\$21,828	\$18,133	\$14,495	\$20,372	\$19,965	\$17,760	\$14,937	\$18,150	\$14,909	\$111,129	\$326,162
Distribution	Service Renewals	\$3,358	\$3,186	\$3,017	\$2,853	\$2,693	\$2,536	\$2,384	\$2,235	\$2,090	\$1,948	\$44,989	\$78,540
	Hydrant Replacement/Relocation	\$206	\$206	\$206	\$206	\$206	\$206	\$206	\$206	\$206	\$206	\$2,073	\$4,549
	Water Main Extensions	\$690	\$690	\$690	\$690	\$690	\$690	\$690	\$690	\$690	\$690	\$7,529	\$15,807
	New Hydrants	\$13	\$13	\$13	\$13	\$13	\$13	\$13	\$13	\$13	\$13	\$126	\$276
	New Taps	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$6,730	\$77,012	\$157,774
	Distribution System Improvements	\$502	\$497	\$498	\$499	\$500	\$500	\$500	\$500	\$500	\$499	\$5,005	\$11,000
	Seismic Upgrades - Distribution	\$8,256	\$8,256	\$8,256	\$3,256	\$3,256	\$3,705	\$3,705	\$3,705	\$3,705	\$3,705	\$59,133	\$127,005
	Water Main Rehabilitation	\$24,887	\$24,873	\$24,858	\$24,843	\$24,828	\$24,753	\$24,733	\$24,712	\$24,691	\$24,670	\$142,779	\$440,476
	Multiple Utility Relocations	\$431	\$431	\$431	\$431	\$431	\$431	\$431	\$431	\$431	\$431	\$4,422	\$9,596
	Tank Improvements	\$1,875	\$3,874	\$2,499	\$1,623	\$1,222	\$244	\$1,471	\$2,947	\$244	\$113	\$17,306	\$37,071
	Pump Station Improvements	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$5,117	\$10,165
	In-Line Gate Valve Improvements	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$421	\$3,760	\$8,808
	Air Valve Chamber Upgrades	\$28	\$28	\$28	\$28	\$28	\$28	\$28	\$28	\$28	\$28	\$576	\$907
	Distribution System Modifications	\$101	\$101	\$101	\$101	\$101	\$101	\$101	\$101	\$101	\$101	\$1,018	\$2,234
	Meter Replacements/AMR	\$564	\$564	\$564	\$564	\$564	\$564	\$564	\$564	\$564	\$564	\$5,377	\$12,143
	Transportation-Related Projects	\$9,002	\$8,997	\$9,000	\$8,997	\$9,002	\$9,001	\$9,001	\$9,002	\$8,998	\$8,999	\$124,232	\$232,231
Distribution Total		\$57,486	\$59,286	\$57,733	\$51,677	\$50,005	\$50,344	\$51,398	\$52,706	\$49,831	\$49,538	\$500,454	\$1,148,582
Major Watersheds	Watershed Roads and Bridges	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$1,878	\$3,421
	Hatchery and Fish Ladder Improvements	\$7,077	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$6,234	\$15,276	\$28,587
	Habitat Conservation Program	\$310	\$218	\$216	\$292	\$210	\$163	\$235	\$155	\$151	\$218	\$9,534	\$12,119
Major Watersheds Total		\$7,387	\$218	\$216	\$292	\$210	\$163	\$235	\$155	\$151	\$6,452	\$26,688	\$44,127
Other*	Water System Plans	\$0	\$0	\$0	\$0	\$0	\$156	\$522	\$321	\$58	\$0	\$1,046	\$2,160
	In-Town Facilities	\$2,282	\$2,838	\$3,378	\$5,093	\$2,725	\$2,033	\$1,983	\$2,545	\$1,321	\$779	\$58,311	\$88,030
	Regional Facilities	\$1,557	\$483	\$135	\$131	\$128	\$281	\$427	\$1,221	\$2,265	\$397	\$35,966	\$45,480
	Integrated Control/Monitoring Program	\$310	\$310	\$310	\$310	\$310	\$310	\$310	\$310	\$310	\$310	\$3,184	\$6,909
	Security Improvements	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$1,121	\$10,967	\$24,419
	Heavy Equipment Purchases	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$1,811	\$18,389	\$40,119
	1% for Arts	\$251	\$251	\$251	\$251	\$251	\$251	\$251	\$251	\$251	\$251	\$2,433	\$5,446
	Technology	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$3,657	\$38,661	\$82,548
	Other* Total	\$10,990	\$10,472	\$10,663	\$12,375	\$10,004	\$9,621	\$10,083	\$11,237	\$10,795	\$8,326	\$168,957	\$295,111
GRAND TOTAL		\$101,601	\$94,503	\$91,079	\$82,888	\$83,531	\$84,229	\$81,089	\$80,625	\$80,496	\$80,772	\$914,201	\$1,960,232

* Other includes Water System Plans, Facilities, SCADA, Security, Heavy E

2018 shown for completeness

**SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN**

D. MISCELLANEOUS

**APPENDIX D-3
Land Use and Zoning Maps**

LAND USE AND ZONING MAPS

Land Use Zoning Maps provided here were downloaded on September 22, 2017 from the following websites, except as noted. The City of Seattle Zoning map was downloaded on February 23, 2018 and the City of Lake Forest Park map was downloaded on June 6, 2018. For maps not provided, please refer to the website listed below.

City of Seattle

Generalized Zoning Map (attached):

<http://www.seattle.gov/dpd/research/GIS/webplots/smallzonemap.pdf>

Zoning Maps Online: <http://www.seattle.gov/dpd/toolsresources/zoningmapbooks/default.htm>

City of Shoreline

Zoning 2016 (attached):

<http://cosweb.ci.shoreline.wa.us/uploads/attachments/gis/maps/Zoning.pdf>

Comprehensive Plan (attached):

<https://s3.amazonaws.com/CityMaps/complu.pdf>

Zoning Maps Online: <http://www.shorelinewa.gov/government/departments/public-works/maps-gis/frequently-requested-maps>

City of Lake Forest Park

Zoning (attached):

<https://www.cityoflfp.com/DocumentCenter/View/27/LFP-Zoning-2015>

Zoning Maps Online: <https://www.cityoflfp.com/161/Maps>

City of Burien

Zoning (attached):

https://burienwa.gov/UserFiles/Servers/Server_11045935/Image/maps/Zoning_Address_091517.pdf

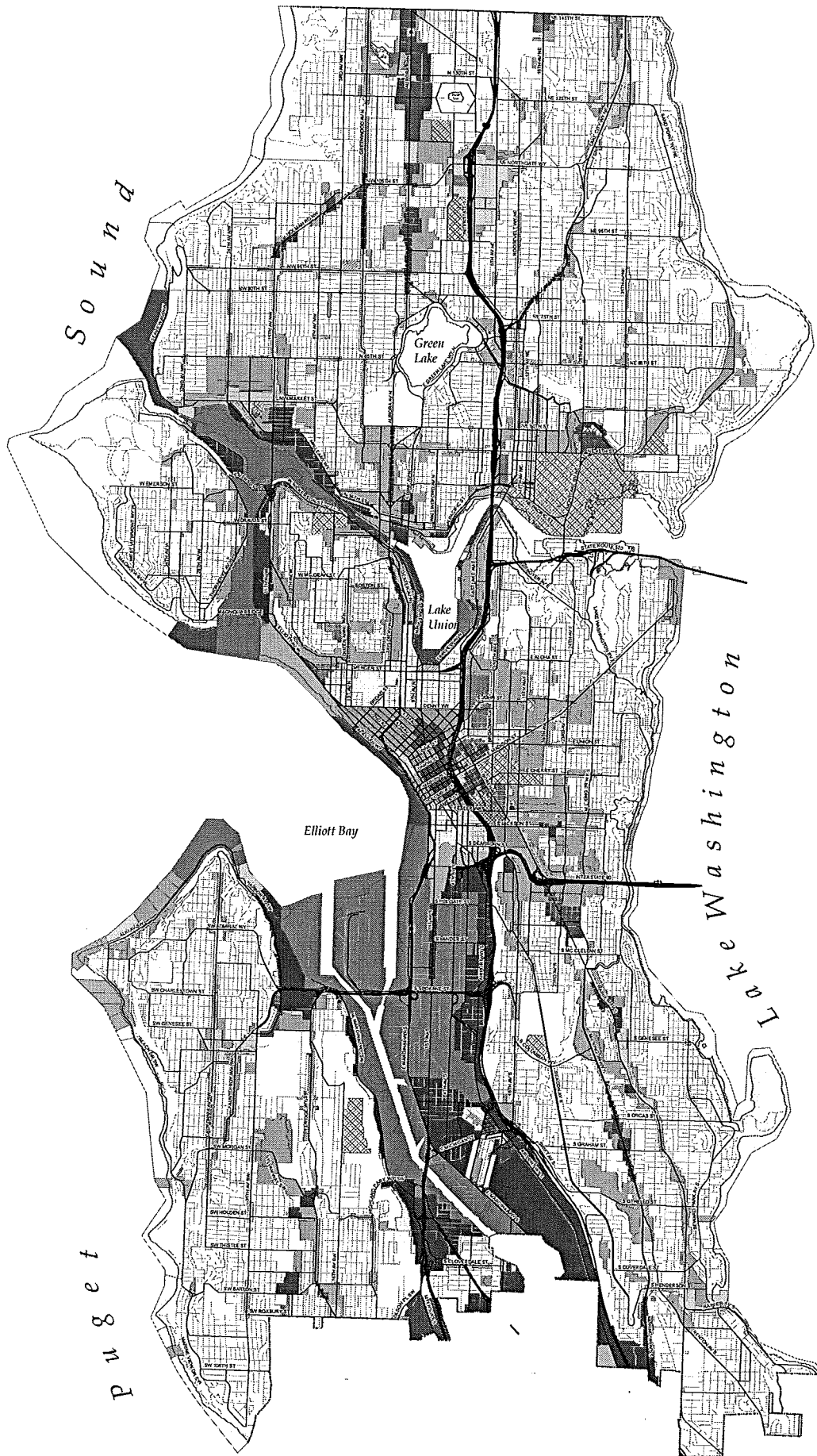
Zoning Maps Online: https://burienwa.gov/city_hall/laws_regulations/zoning

King County

Zoning:

<http://www.kingcounty.gov/depts/permitting-environmental-review/gis/ZoningAtlas.aspx>

The paper Zoning Atlas has been replaced by an interactive web application called iMap, made available to the public by the KCGIS Center at above link.



City of Seattle

Generalized Zoning

as of November 10, 2017

Legend

- Incentive Zones
- Single Family 5000
- Single Family 7200
- Single Family 9600
- Residential Small Lot
- Lowrise
- Midrise
- Highrise
- Seattle Mixed
- Neighborhood Commercial
- Commercial
- Downtown Office Core
- Downtown Harborfront
- Downtown Mixed
- International District
- Pike Market Mixed
- Pioneer Square Mixed
- Industrial Buffer
- Industrial Commercial
- Industrial General 1
- Industrial General 2
- Major Institution
- Master Planned Community
- Pedestrian Areas

Note: This map is a view of generalized zoning only. For precise zoning information, please call or visit the Seattle Municipal Tower, Seattle Department of Construction and Inspections SDCI at 700 5th Ave Suite 2000, 206-684-8850.



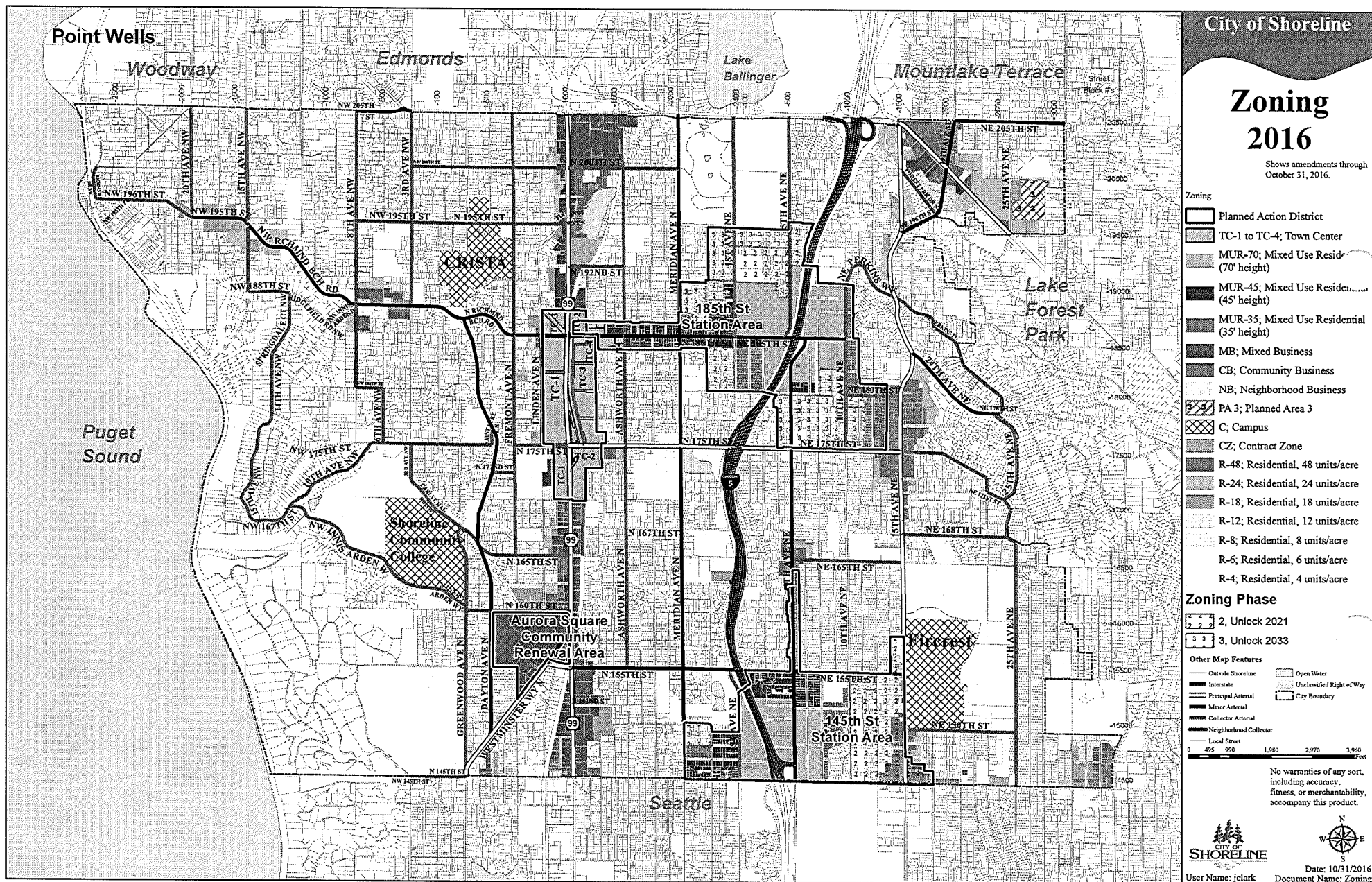
0 1 2 Miles

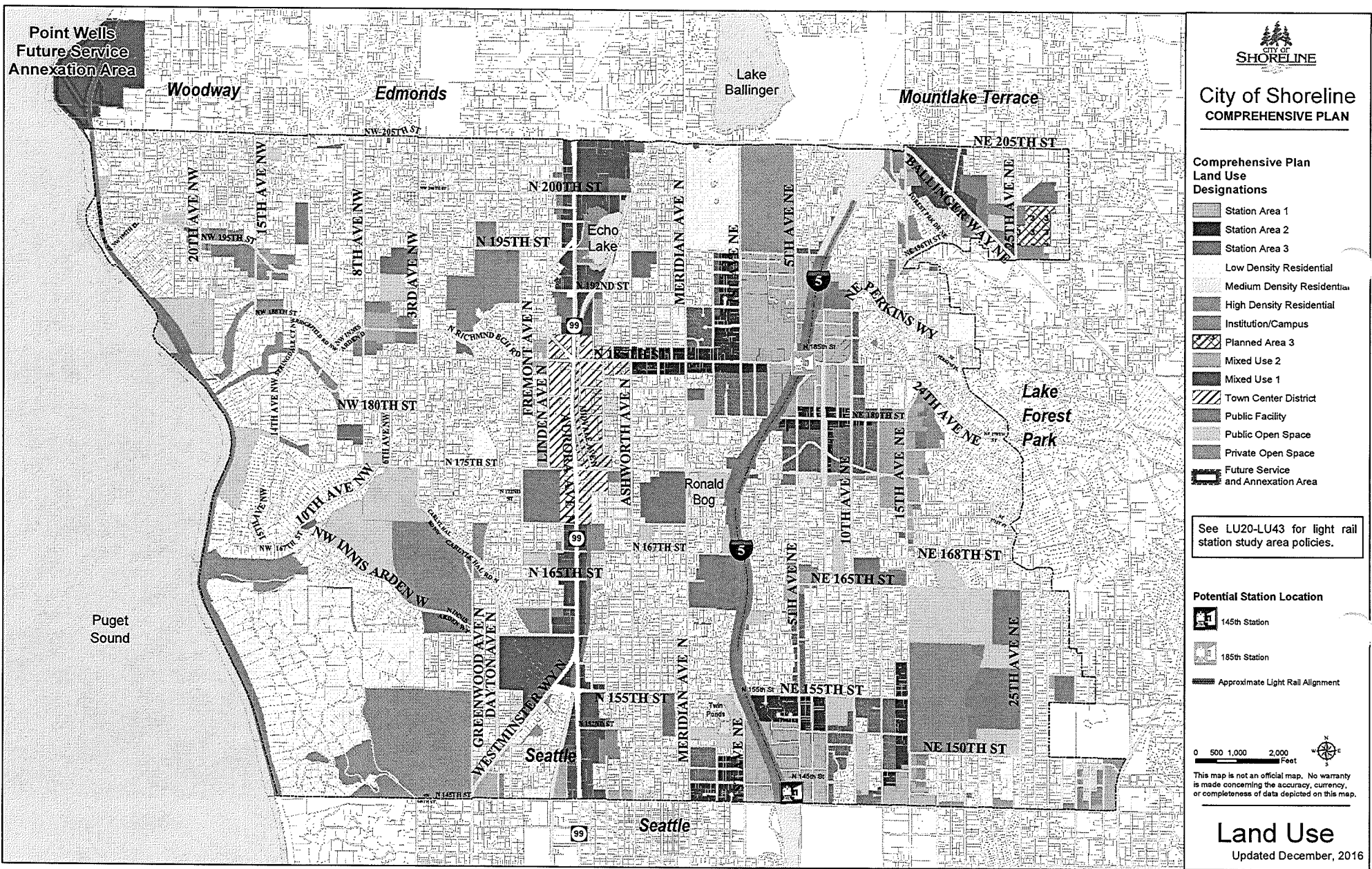
Prepared by:
Seattle Department of Construction and Inspections - SDCI

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Revised by ORD. 675 - Effective August 29, 2017

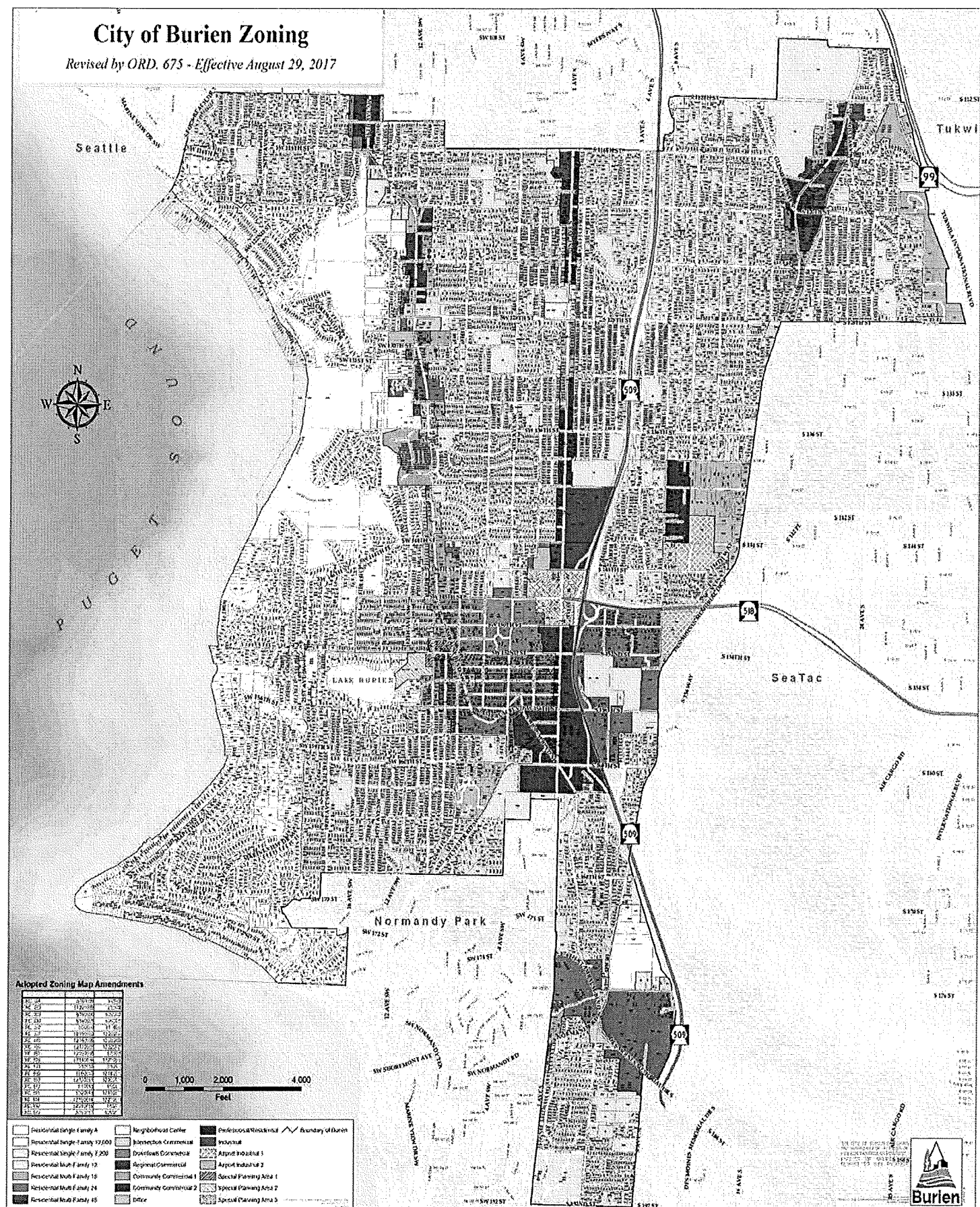
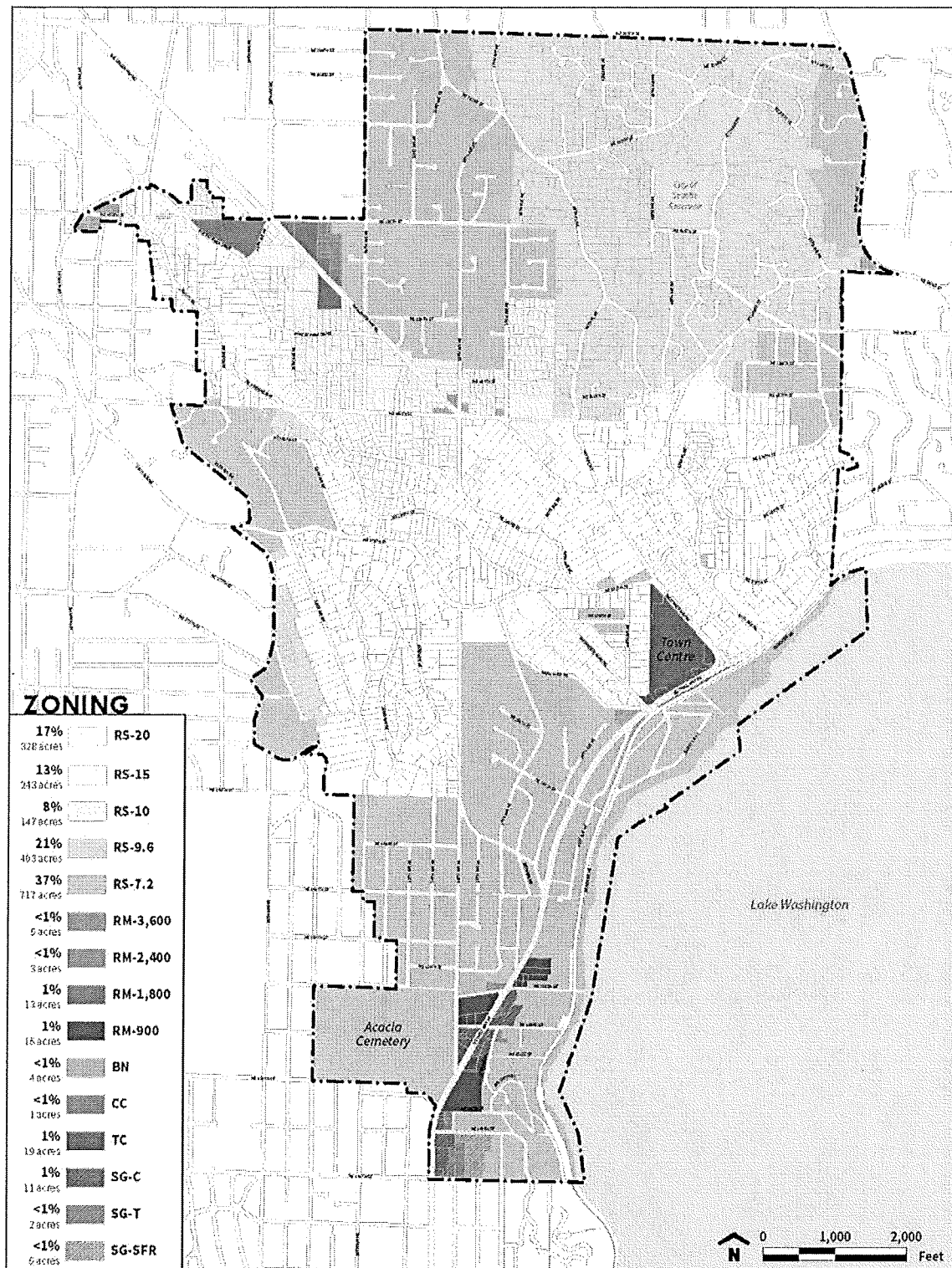


Figure 4. Lake Forest Park Zoning Designations and Acreage



Source: Map created by Studio 3MW using data provided by the City of Lake Forest Park in 2014.

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SEATTLE PUBLIC UTILITIES
2019 WATER SYSTEM PLAN

D. MISCELLANEOUS

APPENDIX D-4
Plan Content and Consistency Review Checklists

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Seattle Public Utilities
2019 Water System Plan
Plan Content Checklist
July 2018

Water System Planning Handbook Chapter	Water System Plan	
	Section	Comments
Chapter 1 - Description of Water System		
Ownership and Management		
System Name	1.1, B-1	
Type of Ownership	1.1, B-1	
Management Structure	B-2	
Water Facilities Inventory Report Form	B-1	
System Background		
History of Water System Development and Growth	1.1	
Geography	1.1	
Neighboring/Adjacent Purveyors	1.4.2.5	
Ordinances/By Laws	1.2	
	7.1	
Inventory of Existing Facilities		
Description of Facilities and Major Components	2.3 3.3 4.3 5.3 B-4	
Number of Service Connections (Existing and Approved)	2.3 5.3.1.4 B-4	Approved number of connections is not applicable.
Existing Interties	2.3.1.3 B-4	SPU does not use interties as a normal source of supply.
Related Plans		
List of Related Plans	1.4.2	
Comments From Agencies and Adjacent Purveyors		Comments from agencies and public sent under separate cover
Responses to Comments		Sent separately
Existing Service Area and Characteristics		
Existing Service Area Map	1.1 2.3	See Figures 1-1 and 2-1.
Zoning and Land Use	D-3	
Future Service Area		
Future Service Area Map	2.3	
Zoning and Land Use	D-3	
Service Area Agreements	2.3.1.3	Wholesale water contracts provided to WDOH under separate cover, as they become available.
Service Area Policies	1.2	Service Area Policy from 2007 WSP carried forward.
Satellite Management	1.1.2	Not applicable.
Condition of Service Policies	1.2 C-3, C-4, C-6, C-7	Service Area Policy from 2007 WSP carried forward.

Water System Planning Handbook Chapter	Water System Plan	
	Section	Comments
Complaints		
Policy	3.3.7.3	
Recordkeeping	5.3.3.5	
Chapter 2 - Basic Planning, Data and Water Demand Forecasting		
Current Population, Service Connections, Water Use, and Equivalent Residential Units		
Current Population	2.3	
Total Service Connections	2.3	
Water Use Data Collection	2.3.2 A-1 A-4	
Equivalent Residential Units		Not applicable
Projected Land Use, Future Population, and Water Demand		
Projected Land Use	2.4.1.2 A-1 D-3	
Projected Population	A-1	
Projected Non-Residential Water Needs	2.4.1.2 A-1	
Projected Non-Revenue Water	A-1	
Water Rates and Rate Impacts on Water Demand	2.4.1.2 A-1	
Water Demand Forecasting	2.4.1.2 A-1	
Chapter 3 – System Analysis		
System Design Standards	C-2	-City of Seattle Standard Plans and Specifications sent separately when updated
Water Quality Analysis		
Historical Review of Trends	3.3	
Future Requirements	3.4	
System Description and Analysis		
Source	2.3 – 2.4 A-3 A-4	
Water Treatment	3.3 – 3.4 B-3, B-4	
Storage	3.3.6 B-4	
Distribution System/Hydraulic Analysis	5.3 – 5.4 D-1	
Identification of System Improvements	2.4 – 2.5	
Assessment of Alternatives	3.3 – 3.5	
Prioritizing Improvements	4.4 – 4.5	
Selection of Alternatives	5.4 – 5.5 6	

Water System Planning Handbook Chapter	Water System Plan	
	Section	Comments
Chapter 4 - Conservation Program, Water Right Analysis, System Reliability and Interties		
Conservation Program Development and Implementation		
Required Measures For All Systems Other Measures and Level of Implementation Conservation Program Outline Regional Conservation Programs	2.4.1.1	
Source of Supply Analysis		No new water rights to be pursued in next 20 years
Enhanced Conservation Measures	2.4.1.1	
Water Right Changes	2.3.4.2 A-2	
Interties		SPU has no plans to use interties for normal supply purposes.
Artificial Recharge		Not applicable for pending water right permit application
Use of Reclaimed Water, Reuse, and other Non-potable Sources	2.4.1.4 A-5	
Treatment	3.3.5 3.4 B-3 B-4	
Water Right Evaluation		
Permits, Certificates, Claims and Applications – Narrative Existing Water Right(s) Status Forecasted Water Right(s) Status Water Rights, Current Water Usage and Projected Needs Assessment of Need for Additional Water Rights	2.3.4.2 A-2	
Water Reservations		Not applicable
Water Supply Reliability Analysis		
Summary of System Reliability Efforts	2.3.4.3	
Water Shortage Response Planning	2.3.5.3 A-6	
Monitoring Well Levels	A-3	
Interties		
Existing Interties	2.3.1.3 B-4	
New Intertie Proposals	.	See 2007 WSP; no change in policy.
Intertie Agreements	2.3.1.3	Wholesale water contracts provided to WDOH under separate cover, as they become available.
Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	2.4 – 2.5 6	

Water System Planning Handbook Chapter	Section	Water System Plan Comments
Chapter 5 - Source Water Protection		
Wellhead Protection Program	3.3.3.2	See also Seattle Public Utilities, <i>Highline Wellfield Wellhead Protection Program</i> , 2000. Unchanged since approval with 2001 WSP, except for potential contaminant inventory updated every other year.
Watershed Control Program	3.3.3.1	See also Seattle Public Utilities, <i>Watershed Protection Plan</i> , November 2017, covering Cedar River Municipal Watershed, South Fork Tolt Municipal Watershed, Lake Youngs Reservation, which was approved April 2018.
Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	3.4	Refer also to Wellhead Protection and Watershed Protection Plans, above.
Chapter 6 - Operation and Maintenance Program		
Water System Management and Personnel	B-2	
Operator Certification	B-2	
System Operations and Control		See Seattle Public Utilities, <i>System Operations and Control</i> , 2018.
Identification of Major System Components	2.3 3.3 4.3 5.3 B-4	
Routine System Operation	2.3.5 3.3.7 4.3.2 5.3.2	See Seattle Public Utilities, <i>System Operations and Control</i> , 2018.
Preventative Maintenance Program	2.3 3.3.8 4.3.3 5.3.3	
Equipment, Supplies and Chemical Listing	B-3 B-4	
Comprehensive Monitoring (Regulatory Compliance) Plan	3.3.7.1 C-1	
Emergency Response Program Water System Personnel Emergency Call-Up List Notification Procedures Vulnerability Analysis Contingency Operational Plan		Sent separately.
Safety Procedures		See 2007 WSP; no significant changes.
Cross-Connection Control Program	3.3.7.2	
Customer Complaint Response Program	3.3.7.3	

Water System Planning Handbook Chapter	Water System Plan	
	Section	Comments
Recordkeeping and Reporting	5.3.3.5	
O & M Improvements	2.3 - 2.5	
Identification of System Improvements	3.3 - 3.5	
Assessment of Alternatives	4.4 - 4.5	
Prioritizing Improvements	5.3 - 5.5	
Selection of Alternatives		
Chapter 7 - Distribution Facilities Design and Construction Standards		
Project Review Procedures		
Policies and Requirements for Outside Parties	5.4.5 C-2, C-3, C-4, C-6, C-7	
Design Standards (Performance Standards and Sizing Criteria)		
Construction Standards (Materials and Methods)	C-2	-City of Seattle Standard Plans and Specifications sent separately when updated
Construction Certification and Follow-up Procedures	C-3	
Identification of System Improvements	5.4 - 5.5	
Assessment of Alternatives		
Prioritizing Improvements		
Selection of Alternatives		
Chapter 8 - Improvement Program		
Improvement Schedule	6 D-2	
Chapter 9 - Financial Program		
Water Systems with 1,000 or More Connections (Not Regulated by UTC)		
Past and Present Financial Status	7.2	
Available Revenue Sources	7.2 7.3	
Allocation of Revenue Sources	7.4	
Program Justification	7.4 7.5	
Assessment of Rates	7.3	
Chapter 10 - Miscellaneous Documents		
Supportive Documents		
State Environmental Policy Act		Separately bound
Other Documents	D-4	Local government consistency certifications
Agreements		Sent separately
Comments on WSP from County		To be sent separately as appropriate
Comments on WSP from Adjacent Utilities		To be sent separately as appropriate

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Local Government Consistency Determination Form

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2019 Water System Plan Plan Date: March 2018

Local Government with Jurisdiction Conducting Review: City of Burien

Before the Department of Health (DOH) approves a planning or engineering submittal under Section 100 or Section 110, the local government must review the documentation the municipal water supplier provides to prove the submittal is consistent with **local comprehensive plans, land use plans and development regulations** (WAC 246-290-108). Submittals under Section 105 require a local consistency determination if the municipal water supplier requests a water right place-of-use expansion. The review must address the elements identified below as they relate to water service.

By signing this form, the local government reviewer confirms the document under review is consistent with applicable local plans and regulations. If the local government reviewer identifies an inconsistency, he or she should include the citation from the applicable comprehensive plan or development regulation and explain how to resolve the inconsistency, or confirm that the inconsistency is not applicable by marking N/A. See more instructions on reverse.

Local Government Consistency Statement	For use by water system	For use by local government
	Identify the page(s) in submittal	Yes or Not Applicable
a) The water system service area is consistent with the adopted <u>land use and zoning</u> within the service area.	Chapter 1, Section 1.4.2 & Appendix D-3	YES
b) The <u>growth projection</u> used to forecast water demand is consistent with the adopted city or county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Chapter 1, Section 2.4.1.2 & Appendix A-1	YES
c) For <u>cities and towns that provide water service</u> : All water service area policies of the city or town described in the plan conform to all relevant <u>utility service extension ordinances</u> .	Appendix C-6 & C-7	N/A
d) <u>Service area policies</u> for new service connections conform to the adopted local plans and adopted development regulations of all cities and counties with jurisdiction over the service area.	Appendix C-6 & C-7	YES
e) <u>Other relevant elements</u> related to water supply are addressed in the water system plan, if applicable. This may include Coordinated Water System Plans, Regional Wastewater Plans, Reclaimed Water Plans, Groundwater Management Area Plans, and the Capital Facilities Element of local comprehensive plans.	Chapter 1, Section 1.4.2; Chapter 6; Appendix A-5; & Appendix D-2	YES

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.



Signature

DAVID JOHANSON, AICP, SENIOR PLANNER, BURIEN
Printed Name, Title, & Jurisdiction

3/27/18
Date

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

This checklist may be used to meet the requirements of WAC 246-290-108. When using an alternative format, it must describe all of the elements; 1a), b), c), d), and e), when they apply.

For **water system plans (WSP)**, a consistency review is required for the service area and any additional areas where a municipal water supplier wants to expand its water right's place of use.

For **small water system management programs**, a consistency review is only required for areas where a municipal water supplier wants to expand its water right's place-of-use. If no water right place-of-use expansion is requested, a consistency review is not required.

For **engineering documents**, a consistency review is required for areas where a municipal water supplier wants to expand its water right's place-of-use (water system plan amendment is required). For noncommunity water systems, a consistency review is required when requesting a place-of-use expansion. All engineering documents must be submitted with a service area map (WAC 246-290-110(4)(b)(ii)).

A) Documenting Consistency: The planning or engineering document must include the following when applicable.

- a) A copy of the adopted **land use/zoning** map corresponding to the service area. The uses provided in the WSP should be consistent with the adopted land use/zoning map. Include any other portions of comprehensive plans or development regulations that relate to water supply planning.
- b) A copy of the **growth projections** that correspond to the service area. If the local population growth projections are not used, explain in detail why the chosen projections more accurately describe the expected growth rate. Explain how it is consistent with the adopted land use.
- c) Include water service area policies and show that they are consistent with the **utility service extension ordinances** within the city or town boundaries. *This applies to cities and towns only.*
- d) All **service area policies** for how new water service will be provided to new customers.
- e) **Other relevant elements** the Department of Health determines are related to water supply planning. See Local Government Consistency – Other Relevant Elements, Policy B.07, September 2009.

B) Documenting an Inconsistency: Please document the inconsistency, include the citation from the comprehensive plan or development regulation, and explain how to resolve the inconsistency.

C) Documenting a Lack of Local Review for Consistency: Where the local government with jurisdiction did not provide a consistency review, document efforts made and the amount of time provided to the local government for review. Please include: name of contact, date, and efforts made (letters, phone calls, and emails). To self-certify, please contact the DOH Planner.

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Local Government Consistency Determination Form

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2019 Water System Plan Plan Date: March 2018

Local Government with Jurisdiction Conducting Review: City of Lake Forest Park

Before the Department of Health (DOH) approves a planning or engineering submittal under Section 100 or Section 110, the local government must review the documentation the municipal water supplier provides to prove the submittal is consistent with **local comprehensive plans, land use plans and development regulations** (WAC 246-290-108). Submittals under Section 105 require a local consistency determination if the municipal water supplier requests a water right place-of-use expansion. The review must address the elements identified below as they relate to water service.

By signing this form, the local government reviewer confirms the document under review is consistent with applicable local plans and regulations. If the local government reviewer identifies an inconsistency, he or she should include the citation from the applicable comprehensive plan or development regulation and explain how to resolve the inconsistency, or confirm that the inconsistency is not applicable by marking N/A. See more instructions on reverse.

Local Government Consistency Statement	For use by water system	For use by local government
	Identify the page(s) in submittal	Yes or Not Applicable
a) The water system service area is consistent with the adopted <u>land use and zoning</u> within the service area.	Chapter 1, Section 1.4.2 & Appendix D-3	Yes ⁽¹⁾
b) The <u>growth projection</u> used to forecast water demand is consistent with the adopted city or county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Chapter 1, Section 2.4.1.2 & Appendix A-1	Yes ⁽²⁾
c) For <u>cities and towns that provide water service</u> : All water service area policies of the city or town described in the plan conform to all relevant <u>utility service extension ordinances</u> .	Appendix C-6 & C-7	Not Applicable
d) <u>Service area policies</u> for new service connections conform to the adopted local plans and adopted development regulations of all cities and counties with jurisdiction over the service area. <u>LFP</u>	Appendix C-6 & C-7	Yes
e) <u>Other relevant elements</u> related to water supply are addressed in the water system plan, if applicable. This may include Coordinated Water System Plans, Regional Wastewater Plans, Reclaimed Water Plans, Groundwater Management Area Plans, and the Capital Facilities Element of local comprehensive plans.	Chapter 1, Section 1.4.2; Chapter 6; Appendix A-5; & Appendix D-2	Yes

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Signature

Printed Name, Title, & Jurisdiction

Steve Bennett, Plg. Dir of
Lake Forest Park

6/8/18
Date

(1) and (2) - see attached page for footnotes

Attachment to Local Government Consistency Determination Form for SPU 2019 Water System Plan

Review agency: Lake Forest Park

Footnotes:

- (1) Answer to (a) is yes provided that SPU updates the zoning map in Appendix D-3 of the draft plan to be the 2015 zoning map (<https://www.cityoflfp.com/DocumentCenter/View/27>)
- (2) Answer to (b) is yes with the caveat that growth projections used by SPU probably did not take into account rezoning in the southern part of LFP associated with the Southern Gateway Subarea Plan adopted in 2013 (<https://www.cityoflfp.com/384/Southern-Gateway-Development>) but, given SPU's service area, the discrepancy may not be significant.

Local Government Consistency Determination Form

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2019 Water System Plan Plan Date: March 2018

Local Government with Jurisdiction Conducting Review: City of Seattle

Before the Department of Health (DOH) approves a planning or engineering submittal under Section 100 or Section 110, the local government must review the documentation the municipal water supplier provides to prove the submittal is consistent with **local comprehensive plans, land use plans and development regulations** (WAC 246-290-108). Submittals under Section 105 require a local consistency determination if the municipal water supplier requests a water right place-of-use expansion. The review must address the elements identified below as they relate to water service.

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Local Government Consistency Statement	For use by water system	For use by local government
	Identify the page(s) in submittal	Yes or Not Applicable
a) The water system service area is consistent with the adopted <u>land use and zoning</u> within the service area.	Chapter 1, Section 1.4.2 & Appendix D-3	<i>yes</i>
b) The <u>growth projection</u> used to forecast water demand is consistent with the adopted city or county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Chapter 1, Section 2.4.1.2 & Appendix A-1	<i>N/A see attachment</i>
c) For <u>cities and towns that provide water service</u> : All water service area policies of the city or town described in the plan conform to all relevant <u>utility service extension ordinances</u> .	Appendix C-6 & C-7	<i>yes</i>
d) <u>Service area policies</u> for new service connections conform to the adopted local plans and adopted development regulations of all cities and counties with jurisdiction over the service area.	Appendix C-6 & C-7	<i>yes</i>
e) <u>Other relevant elements</u> related to water supply are addressed in the water system plan, if applicable. This may include Coordinated Water System Plans, Regional Wastewater Plans, Reclaimed Water Plans, Groundwater Management Area Plans, and the Capital Facilities Element of local comprehensive plans.	Chapter 1, Section 1.4.2; Chapter 6; Appendix A-5; & Appendix D-2	<i>yes</i>

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Signature

TOM HAUGER, COMPREHENSIVE PLAN MGR., Seattle
Printed Name, Title, & Jurisdiction

Date

6/7/18

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

This checklist may be used to meet the requirements of WAC 246-290-108. When using an alternative format, it must describe all of the elements; 1a), b), c), d), and e), when they apply.

For **water system plans (WSP)**, a consistency review is required for the service area and any additional areas where a municipal water supplier wants to expand its water right's place of use.

For **small water system management programs**, a consistency review is only required for areas where a municipal water supplier wants to expand its water right's place-of-use. If no water right place-of-use expansion is requested, a consistency review is not required.

For **engineering documents**, a consistency review is required for areas where a municipal water supplier wants to expand its water right's place-of-use (water system plan amendment is required). For noncommunity water systems, a consistency review is required when requesting a place-of-use expansion. All engineering documents must be submitted with a service area map (WAC 246-290-110(4)(b)(ii)).

A) Documenting Consistency: The planning or engineering document must include the following when applicable.

- a) A copy of the adopted **land use/zoning** map corresponding to the service area. The uses provided in the WSP should be consistent with the adopted land use/zoning map. Include any other portions of comprehensive plans or development regulations that relate to water supply planning.
- b) A copy of the **growth projections** that correspond to the service area. If the local population growth projections are not used, explain in detail why the chosen projections more accurately describe the expected growth rate. Explain how it is consistent with the adopted land use.
- c) Include water service area policies and show that they are consistent with the **utility service extension ordinances** within the city or town boundaries. *This applies to cities and towns only.*
- d) All **service area policies** for how new water service will be provided to new customers.
- e) **Other relevant elements** the Department of Health determines are related to water supply planning. See Local Government Consistency – Other Relevant Elements, Policy B.07, September 2009.

B) Documenting an Inconsistency: Please document the inconsistency, include the citation from the comprehensive plan or development regulation, and explain how to resolve the inconsistency.

C) Documenting a Lack of Local Review for Consistency: Where the local government with jurisdiction did not provide a consistency review, document efforts made and the amount of time provided to the local government for review. Please include: name of contact, date, and efforts made (letters, phone calls, and emails). To self-certify, please contact the DOH Planner.

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Attachment to Local Government Consistency Determination Form

City of Seattle Water System Plan

There is a discrepancy between the demographic forecasts used in the water demand forecast model and the growth assumed in Seattle's most recent comprehensive plan. As is explained below however, no changes are being proposed.

The City of Seattle adopted its comprehensive plan, "Seattle 2035 – Comprehensive Plan: Managing Growth to Become an Equitable and Sustainable City 2015-2035" in October 2016. On page 431, it states, "Seattle's growth assumptions for the period from 2015 through 2035 are 70,000 net new housing units and 115,000 net new jobs." The primary source of the housing unit numbers is Puget Sound Regional Council's (PSRC) recent Land Use Vision (LUV) forecast of population and households. This forecast was released after SPU had finalized its water demand forecast using an earlier PSRC demographic forecast (Land Use Baseline or LUB) which, unlike the Land Use Vision forecast, provides projections of households disaggregated into single family and multifamily categories and employment, three major inputs for the water demand forecast model.

For SPU's retail service area (the City of Seattle plus smaller areas outside the city limits), the LUB forecast projects total household growth of 47,600 between 2015 and 2035. This is considerably less than the 70,000 new housing units over the same period assumed in the Seattle Comprehensive Plan for the City of Seattle. At first glance, it appears that SPU's water demand forecast may not be consistent with the SCP. However, a closer look at how that projected growth is spread over time suggests the two demographic forecasts are not so far apart over most of the forecast period.

The table below shows the two forecasts of total households in SPU's retail water service area. The first column is based on PSRC's Land Use Baseline forecast used by SPU and the second on the Land Use Vision forecast which was the used as the data source for the comprehensive plan. Both forecasts were provided at the census tract level and were apportioned to SPU's retail service area by SPU staff. The LUV forecast calls for 70,359 new households between 2015 and 2035 while the LUB forecast has considerably less growth with just 47,576 new households. However, the difference is all in the first 5 years when the LUV forecast has more than twice the growth. The LUV forecast of growth is more accurate in the short term and reflects Seattle's phenomenal spike in growth the past 4 years. Between 2000 and 2013, Seattle's population grew at an average rate of 0.8% per year. Since 2014, annual growth as averaged 3.3%! The newer LUV forecast takes this higher recent growth into account whereas the LUB forecast was completed in 2014 and did not anticipate the 2014-2017 spike in Seattle growth. For the rest of the forecast period (2020-2035), the two forecasts are almost identical: 29,771 compared to 29,087 new households.

**Two Forecasts of Total Households
In SPU's Retail Service Area**

	Total Households	
	LUB	LUV
2010	304,815	304,815
2015	322,301	334,910
2020	340,791	375,498
2025	348,772	387,141
2030	356,941	393,903
2035	369,878	405,269
2040	383,284	423,661
Growth		
2015-2035	47,576	70,359
2015-2020	18,490	40,587
2020-2035	29,087	29,771

For the following reasons, we are not recommending that SPU revise its water demand forecast with the newer LUV forecast of households:

- It is now 2018, well into the 2015-2020 period, and the water demand forecast has been closely tracking *actual* demand. Specifically, retail residential water consumption is still in synch with the forecast. If the LUB household forecast were to be replaced by the LUV forecast in the demand forecast model, that would bump the forecast of Seattle water demand above actual its demand over the first few years. Given that it appears likely that the demand forecast and actual demand will remain close through 2020, and that the LUB and LUV forecasts of household growth are near identical post-2020, there's no advantage to switching to the LUV forecast.
- While the LUV forecast of households does exceed the LUB forecast for Seattle, that is not the case for SPU's *wholesale* service area and the rest of King County. Much of the county has not shared in Seattle's recent growth so that the total forecasted household growth for King County *net of Seattle* is actually less in the LUV forecast than in the LUB forecast. SPU is forecasting water demand for it's entire service area – retail and wholesale – and the differences between the LUV and LUB demographic forecasts are somewhat offsetting in the aggregate.
- The LUV forecast is for population and total households only. It does not forecast employment nor disaggregate households into single family and multifamily as required by the water demand forecast model.

Local Government Consistency Determination Form

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2019 Water System Plan Plan Date: March 2018

Local Government with Jurisdiction Conducting Review: City of Shoreline

Before the Department of Health (DOH) approves a planning or engineering submittal under Section 100 or Section 110, the local government must review the documentation the municipal water supplier provides to prove the submittal is consistent with **local comprehensive plans, land use plans and development regulations** (WAC 246-290-108). Submittals under Section 105 require a local consistency determination if the municipal water supplier requests a water right place-of-use expansion. The review must address the elements identified below as they relate to water service.

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Local Government Consistency Statement	For use by water system	For use by local government
	Identify the page(s) in submittal	Yes or Not Applicable
a) The water system service area is consistent with the adopted <u>land use and zoning</u> within the service area.	Chapter 1, Section 1.4.2 & Appendix D-3	YES MAPS CURRENT
b) The <u>growth projection</u> used to forecast water demand is consistent with the adopted city or county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Chapter 1, Section 2.4.1.2 & Appendix A-1	YES STATION AREA GROWTH PLANS COORD. WITH SPU AND ICE, PSRC, OFM
c) For <u>cities and towns that provide water service</u> : All water service area policies of the city or town described in the plan conform to all relevant <u>utility service extension ordinances</u> .	Appendix C-6 & C-7	N/A - City is not a water provider.
d) <u>Service area policies</u> for new service connections conform to the adopted local plans and adopted development regulations of all cities and counties with jurisdiction over the service area.	Appendix C-6 & C-7	YES - in SPU WSP Appendix C6 & C7
e) <u>Other relevant elements</u> related to water supply are addressed in the water system plan, if applicable. This may include Coordinated Water System Plans, Regional Wastewater Plans, Reclaimed Water Plans, Groundwater Management Area Plans, and the Capital Facilities Element of local comprehensive plans.	Chapter 1, Section 1.4.2; Chapter 6; Appendix A-5; & Appendix D-2	YES - In SPU WSP Chapt 1, Section 1.4.2, Chapter 6 & Appendix A-5 & D-2

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Randy Witt

Signature

Randy Witt, Public Works Director

Printed Name, Title, & Jurisdiction

3/28/18

Date

RIL. CL, PCD, Planning Manager

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

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For **small water system management programs**, a consistency review is only required for areas where a municipal water supplier wants to expand its water right's place-of-use. If no water right place-of-use expansion is requested, a consistency review is not required.

For **engineering documents**, a consistency review is required for areas where a municipal water supplier wants to expand its water right's place-of-use (water system plan amendment is required). For noncommunity water systems, a consistency review is required when requesting a place-of-use expansion. All engineering documents must be submitted with a service area map (WAC 246-290-110(4)(b)(ii)).

A) Documenting Consistency: The planning or engineering document must include the following when applicable.

- a) A copy of the adopted **land use/zoning** map corresponding to the service area. The uses provided in the WSP should be consistent with the adopted land use/zoning map. Include any other portions of comprehensive plans or development regulations that relate to water supply planning.
- b) A copy of the **growth projections** that correspond to the service area. If the local population growth projections are not used, explain in detail why the chosen projections more accurately describe the expected growth rate. Explain how it is consistent with the adopted land use.
- c) Include water service area policies and show that they are consistent with the **utility service extension ordinances** within the city or town boundaries. *This applies to cities and towns only.*
- d) All **service area policies** for how new water service will be provided to new customers.
- e) **Other relevant elements** the Department of Health determines are related to water supply planning. See Local Government Consistency – Other Relevant Elements, Policy B.07, September 2009.

B) Documenting an Inconsistency: Please document the inconsistency, include the citation from the comprehensive plan or development regulation, and explain how to resolve the inconsistency.

C) Documenting a Lack of Local Review for Consistency: Where the local government with jurisdiction did not provide a consistency review, document efforts made and the amount of time provided to the local government for review. Please include: name of contact, date, and efforts made (letters, phone calls, and emails). To self-certify, please contact the DOH Planner.

The Department of Health is an equal opportunity agency. For persons with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TTY 1-800-833-6388).

STATE OF WASHINGTON -- KING COUNTY

--SS.

366813

No.

CITY OF SEATTLE, CLERKS OFFICE

Affidavit of Publication

The undersigned, on oath states that he is an authorized representative of The Daily Journal of Commerce, a daily newspaper, which newspaper is a legal newspaper of general circulation and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continuously as a daily newspaper in Seattle, King County, Washington, and it is now and during all of said time was printed in an office maintained at the aforesaid place of publication of this newspaper. The Daily Journal of Commerce was on the 12th day of June, 1941, approved as a legal newspaper by the Superior Court of King County.

The notice in the exact form annexed, was published in regular issues of The Daily Journal of Commerce, which was regularly distributed to its subscribers during the below stated period. The annexed notice, a

CT:125682-687 TITLE ONLY

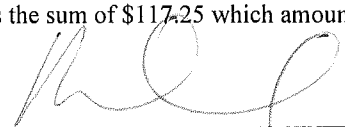
was published on

10/18/18

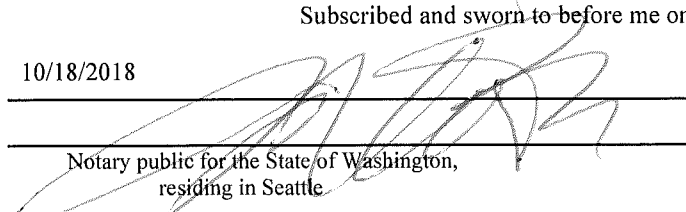
The amount of the fee charged for the foregoing publication is the sum of \$117.25 which amount has been paid in full.



Affidavit of Publication


Subscribed and sworn to before me on

10/18/2018


Notary public for the State of Washington,
residing in Seattle

State of Washington, King County

City of Seattle

The full text of the following legislation, passed by the City Council on October 01, 2018, and published below by title only, will be mailed upon request, or can be accessed at <http://seattle.legistar.com>. For information on upcoming meetings of the Seattle City Council, please visit <http://www.seattle.gov/council/calendar>.

Ordinance 125682

Council Bill 119363

AN ORDINANCE appropriating money to pay certain audited claims and ordering the payment thereof.

Ordinance 125683

Council Bill 119361

AN ORDINANCE relating to Hing Hay Park and property agreements with the Seattle Chinatown International District Preservation and Development Authority (SCIDpda) and the City of Seattle; authorizing the Superintendent of Parks and Recreation to execute a Settlement Agreement and associated documents extinguishing an easement on City-owned real property and modifying a covenant encumbering SCIDpda-owned real property; amending Ordinance 124927, which adopted the 2016 Budget; lifting a proviso; and authorizing use of certain City funds to design and construct a public restroom within the Bush Hotel building to serve users of Hing Hay Park and other members of the public.

Ordinance 125684

Council Bill 119329

AN ORDINANCE relating to employment in Seattle; requiring certain employers to offer employees the opportunity to use pre-tax earnings to purchase commuter benefits, other than parking, in accordance with federal law; adding a new Chapter 14.30 to the Seattle Municipal Code (SMC); and amending Sections 3.15.000 and 6.208.020 of the SMC.

Ordinance 125685

Council Bill 119356

AN ORDINANCE relating to Seattle Public Utilities; amending Sections 21.28.040, 21.28.080, and 21.76.040 of the Seattle Municipal Code to adjust wastewater rates.

Ordinance 125686

Council Bill 119355

AN ORDINANCE relating to Seattle Public Utilities; amending Sections 21.33.030 and 21.76.040 of the Seattle Municipal Code to adjust drainage rates.

Ordinance 125687

Council Bill 119347

AN ORDINANCE relating to Seattle Public Utilities; adopting the 2019 Water System Plan.

Date of publication in the Seattle Daily Journal of Commerce, October 18, 2018.

10/18(366813)