Seattle Public Utilities

2019 WATER SYSTEM PLAN

Our Water. Our Future.

APPENDICES | Volume 2

August 2019

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Seattle Public Utilities

2019 Water System Plan

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August 2019

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APPENDICES

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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	SO1 at CLT-5	Required once every 9 years for all sources.	Last submitted in 2015 for	SPU		EPA and State allow waivers.
Arsenic	SO2 at TPT-3		SO1 and SO2.	SPU		Waivers are applied automatically by the state.
Barium	SO4 at BPW-T		Last submitted in 2012 for	SPU		
Beryllium	SO6 at RHW-T		SO4 and SO6.	SPU		
Cadmium				SPU		
Chromium				SPU		
Copper				SPU		No MCL, AL = 1.3 mg/L
Cyanide				Outside		
Fluoride				SPU		
Lead				SPU		No MCL, AL = 0.015 mg/L
Mercury				Outside		
Nickel				SPU		
Selenium				SPU		
Sodium				SPU		Health Advisory Level = 20 mg/L
Thallium				SPU		
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 S01 & S02 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, endothall, 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	CLT-5, TPT-3, RHW-T, BPW-T	Once every 9 years for SO1, SO4, and SO6.	SO1 and SO2 done in 2015.	Outside		
Color		Once every three years for SO2 (Fe,Mn only)	SO4 and SO6 done in 2012.	SPU		
Fluoride				SPU		
Hardness				SPU		
Iron				SPU		
Manganese				SPU		
Silver				SPU		
Specific Conductivity				SPU		
Sulfate				Outside		
Total Dissolved Solids				SPU		Only required if conductivity > 700 µmhos/cm
Zinc				SPU		
Surface Water Treatment Rule (Tolt)						
Turbidity	TPR-5S 5N, T-CFE, individual filters	Continuous				All Part of DBO Contract
Fecal coliform	TPR-5S 5N	Daily, at least 5 days per week		SPU		
Chlorine Residual	T-FINISH	Continuous				
CT Complaince	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 Complaince	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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Contents

Appendices

List of Figures

List of Tables

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 and 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

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 is 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.

Removed for security

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. Removed for security

Removed for security

Removed for security

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

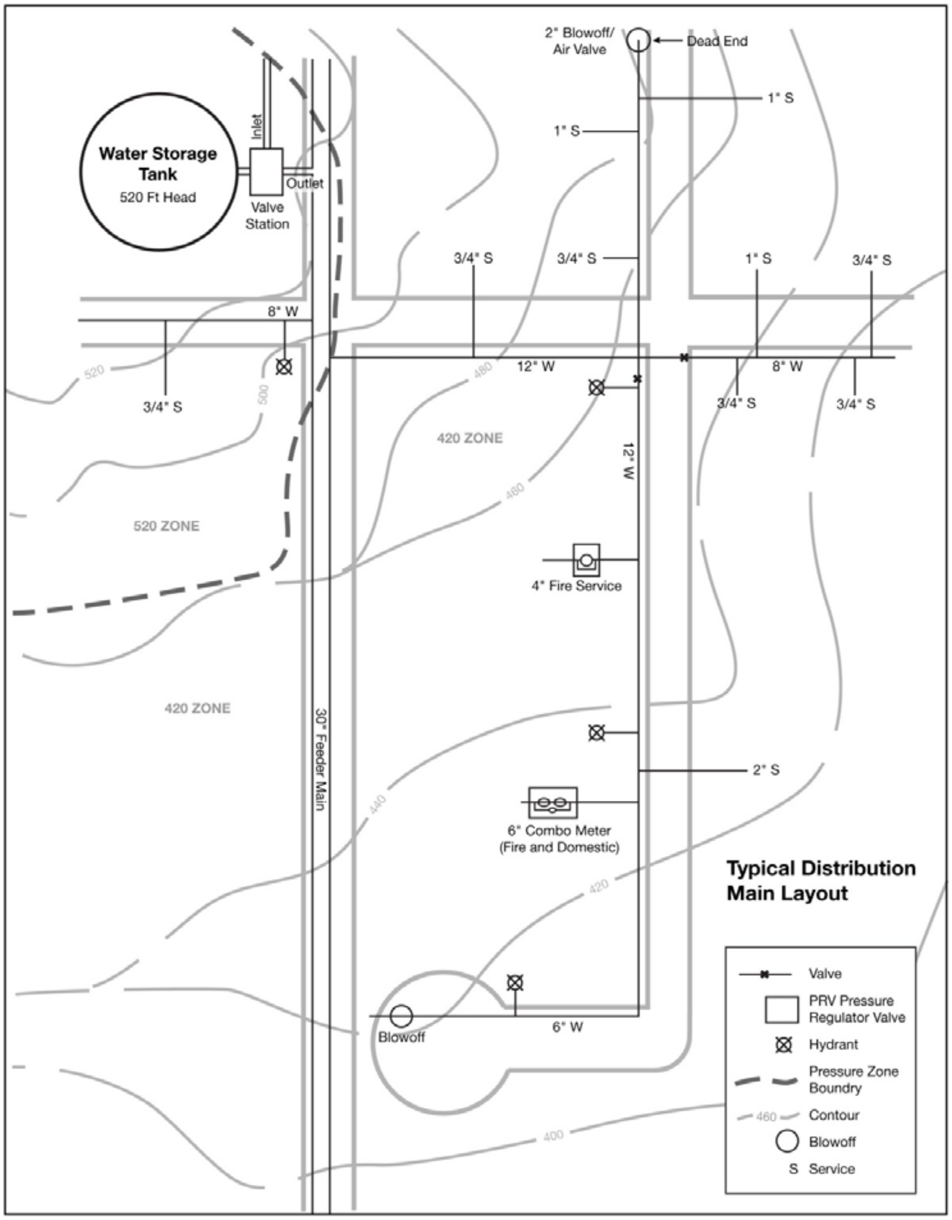
Table 5-1 shows key components in SPU water system infrastructure.

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 pipelines (generally <3 ft) are the backbone of SPU distribution mains. New taps are not permitted on feeder mains except for feeder-distributor mains meeting current design standards for distribution mains.
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 5-3Table 5-2 lists relevant AWWA design manuals for water supply practice. The list is not comprehensive. Removed for security. 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 Ordnances

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, Pw	250 psi	
Design Transient (Surge) Pressure, Pt	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

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5.6.1.1 Pressure Zones

The SPU water distribution system is divided into approximately 45 pressures 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. Removed for security

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 Std Spec 9-30.2. • Casing seals and spacers must be per Std Spec 9-30(15).

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

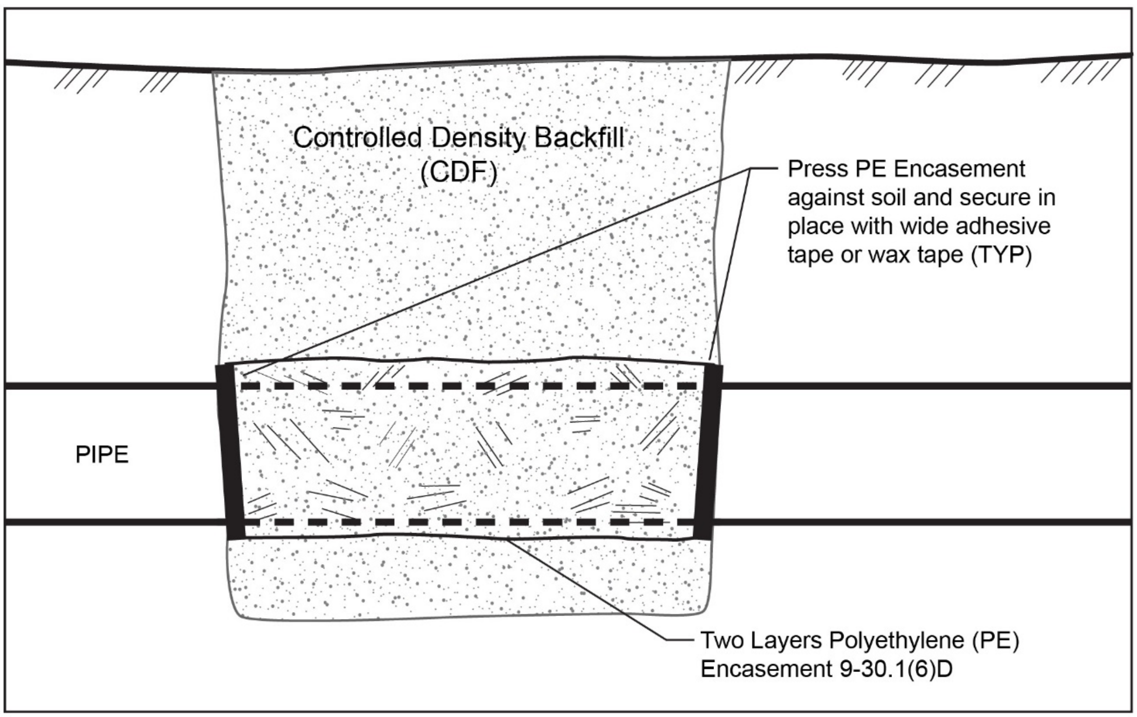
Sometimes an outside agency, time constraints, or compaction will require that a water main be bedded and backfilled in controlled density fill (CDF). When this requirement outweighs the benefit of using sand bedding, a metallic water main must be protected where it is embedded in CDF. The protection 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 ⅓ 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 5.10, 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.

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. <u>SPU does not use threaded couplings in water mains</u>.

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.

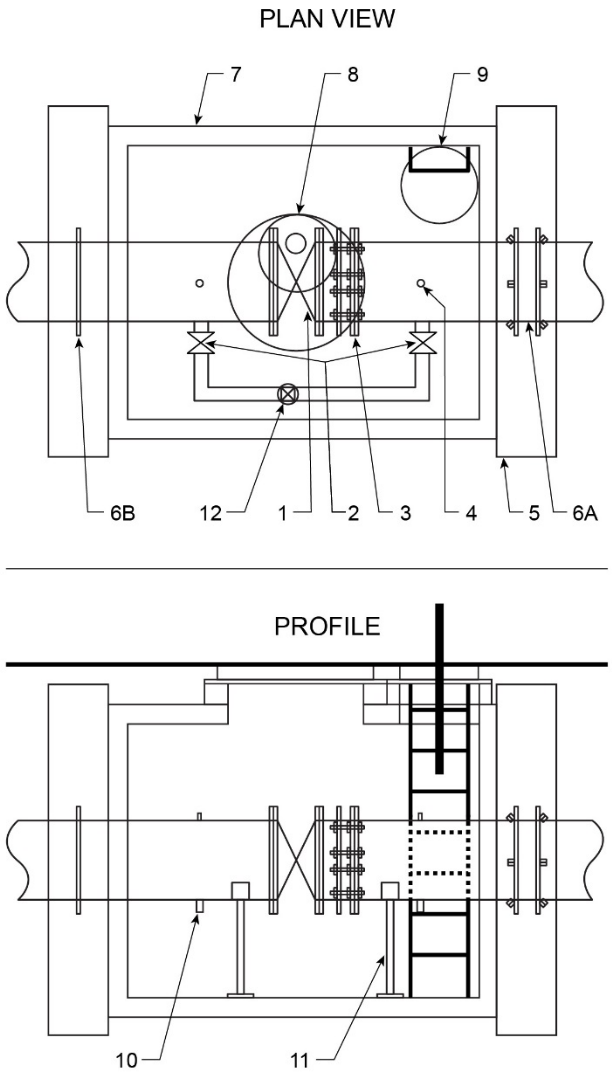
Valve chambers are required for all water system valves 16 inches and larger, for valves that separate service pressure zones (district valves) and for all buried installations that have electrical service and electronic sensors. Chambers are also provided for transmission main blowoff valves, large 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 fasting 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.

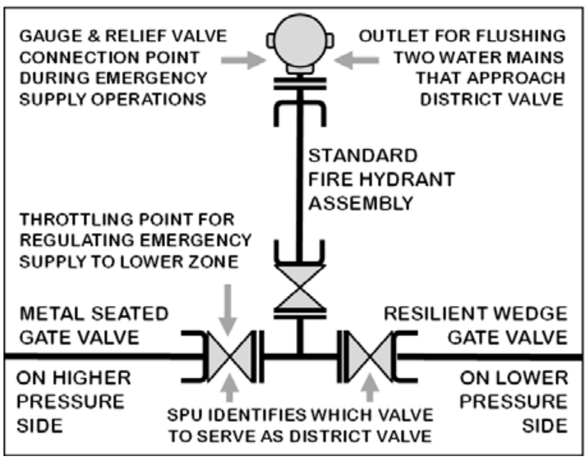
The term isolation valve is also used for valves installed on both sides of appurtenances such as pumps, modulating valves, and meters, which must be periodically removed from service for inspection or maintenance.

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 gates 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 insistence, a PRg between the 585 SZ and the 480SZ would be (585'-480')/(2.31'/ psi) = 45.4 psi.
3. Obtain the PRg's C_v from the manufacturer's published literature.
4. Knowing Cv and ΔP_{PRg}, calculate an initial maximum flow through the PRg: $Q_{gpm} = C_v / \text{sqrt}(1/\Delta P_{PRg})$
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: $C_v = Q_{gpm} * \text{sqrt}(1/\Delta P_{PRV})$
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.

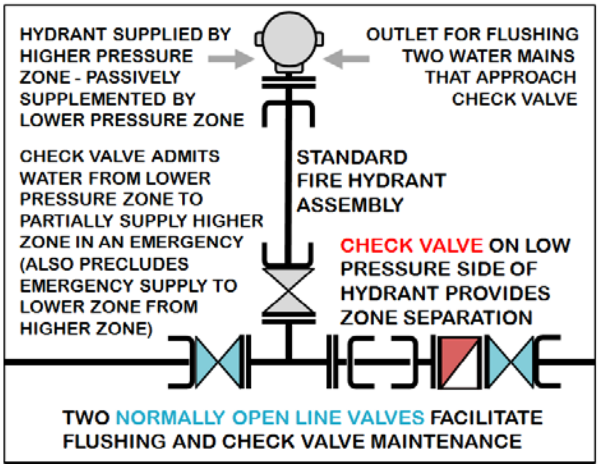
Pump discharge check valves act quickly and automatically on pump discharges to prevent return flow through the pump in the event of a power loss. Non-slam characteristics are essential in check valve selection for this application. The check valve size is selected to match the pump discharge. It is 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 1/15th). 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:

SCFM = CFM * (internal pressure, psia/14.7psia)*(528°R/Pipeline Temperature °R)

Where °R = (°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 5-6Table 5-5. 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 and Vacuum Combination Air Valve	Air Release Valve (ARV), AWWA C514 Air Vacuum Valve (AVV), AWWA C514 Combo Air Valve (CAV), AWWA C514	¾" - 2 2" – 16" 4" – 16"	• Air release through a small orifice • Large orifice air valve • Allows air into or out of pipe during draining or filling. • Performs function of both admitting into and exhausting air out of pipe
Pressure Regulating Valve (PR valve) Pressure Relief Valve (PRV)	Control Valve, AWWA C530	2"-16" 2" – 8"	• Maintains a constant downstream pressure • 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.

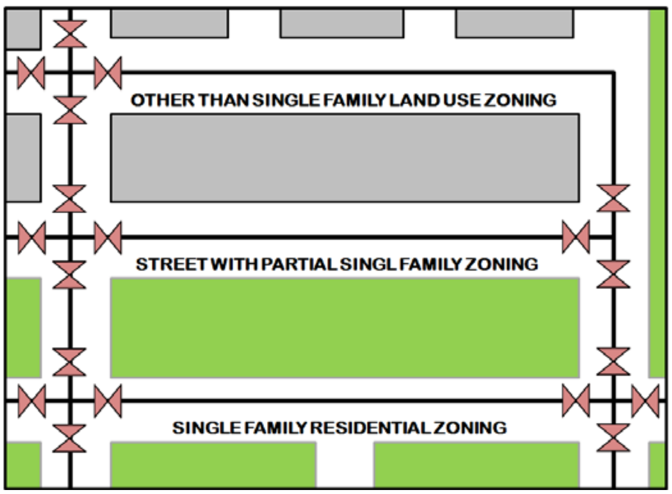
1) Isolation at all nodes in the grid and networks

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

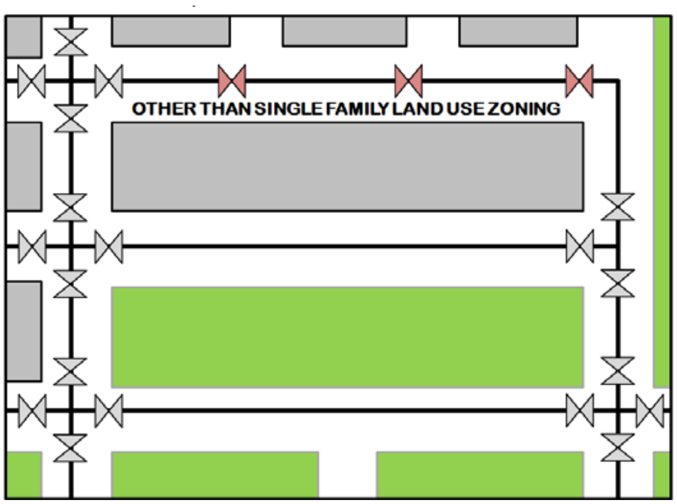
Provide valves on all mains at grid junctions, for all zoning designations, as shown in Figure 5-8.

Figure 5-8
Example of Valves on All Mains at Grid Junctions



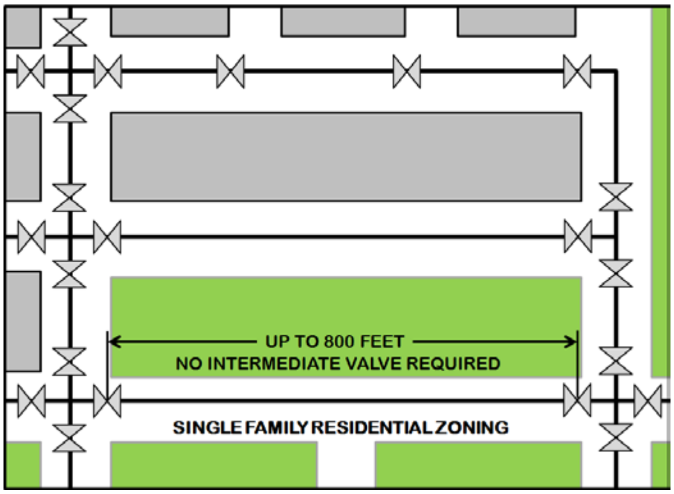
Additional intermediate line valves are required between grid connections, such that any single shutdown segment will be no more than one block or 500 feet in length, whichever is less (except in SFR Zones). See Figure 5-9.

Figure 5-9
Example of Intermediate Valves at Cross Streets



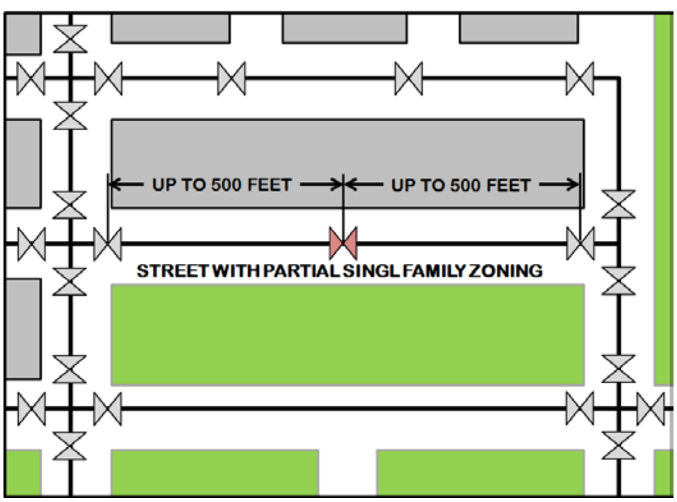
Single-family residential exception: In single-family residential zones, line valves are required on all water mains approaching a grid junction. However, intermediate line valves between junctions are required only as needed to create water main shutdown segments not to exceed 800 feet in length. See 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.

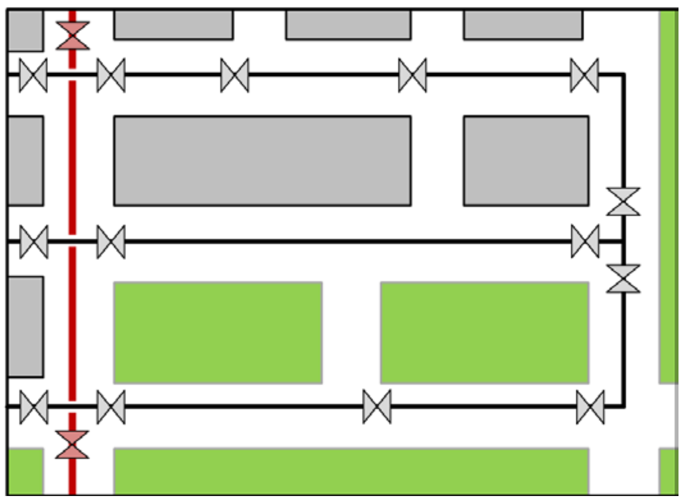
Figure 5-11
Example of Intermediate Valve Spacing – Partial SFR Zoning



3) Valve Placement along Feeder Mains in the Distribution System

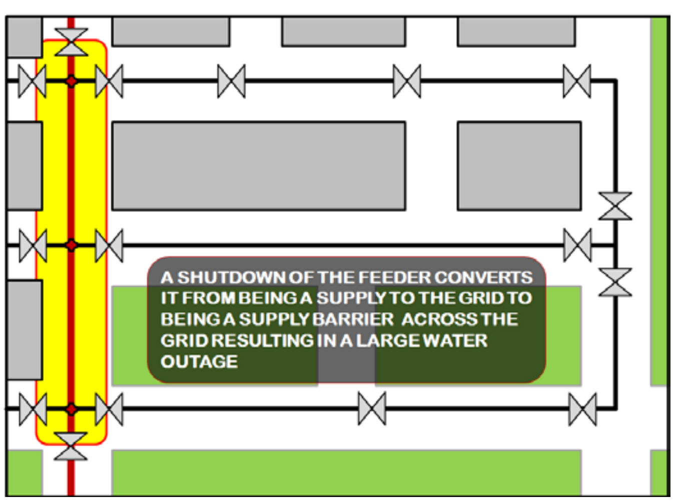
On distribution mains and feeder mains larger than 12 inches in diameter, valves must be located where these mains intersect with other mains larger than 12 inches, such that each of the converging large diameter main segments can be independently isolated. Additional intermediate valves are required 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.

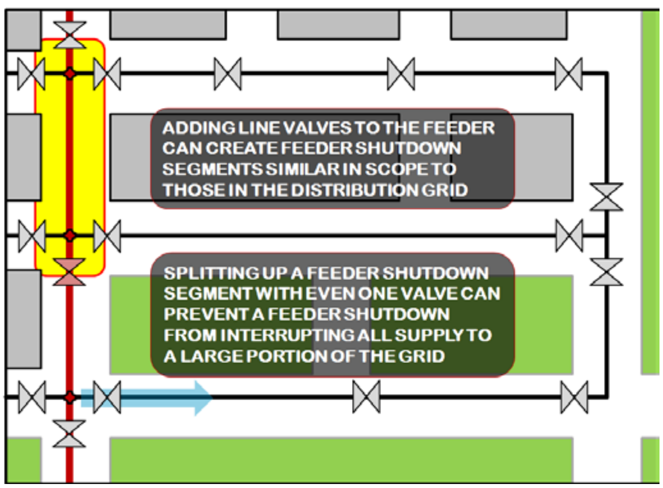
Figure 5-13
Example of 1/4 Mile Valve Spacing Not Appropriate with Grid-Integrated Feeder



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.

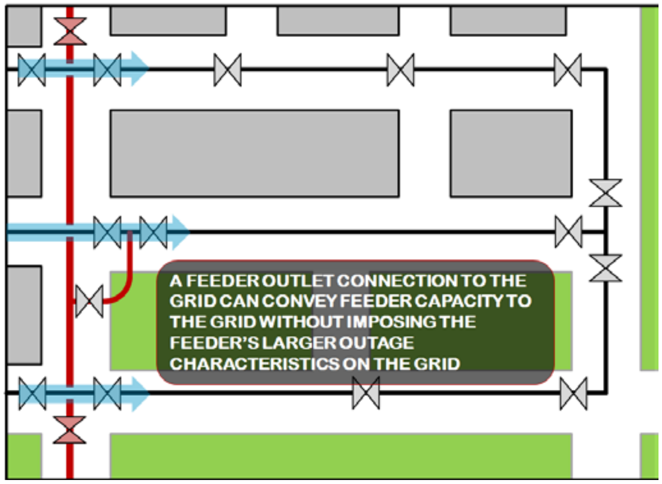
To protect the distribution grid from the effects of less frequent valve placement along large-diameter mains, the simplest modification is to add valves to the larger main to create shutdown segments no larger than what would be allowed for a distribution grid main. Because of the expense and street 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



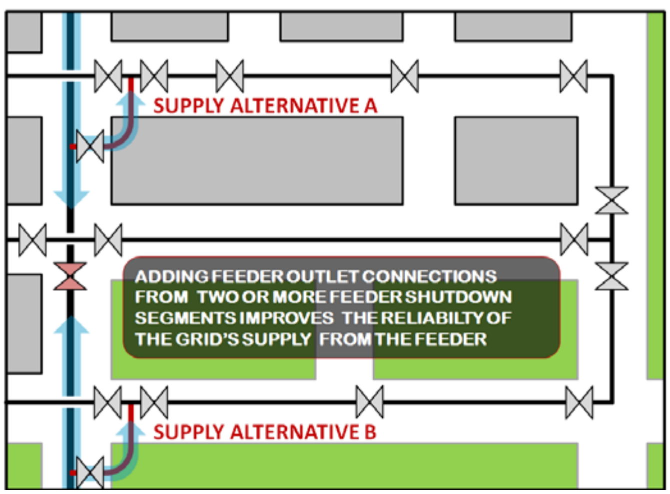
The shutdown/outage implications caused by infrequent placement of costly large-diameter line valves can also be addressed by not fully integrating the large main into the surrounding distribution grid. See Figure 5-15.

Figure 5-15
Main Separation between Feeder and Grid



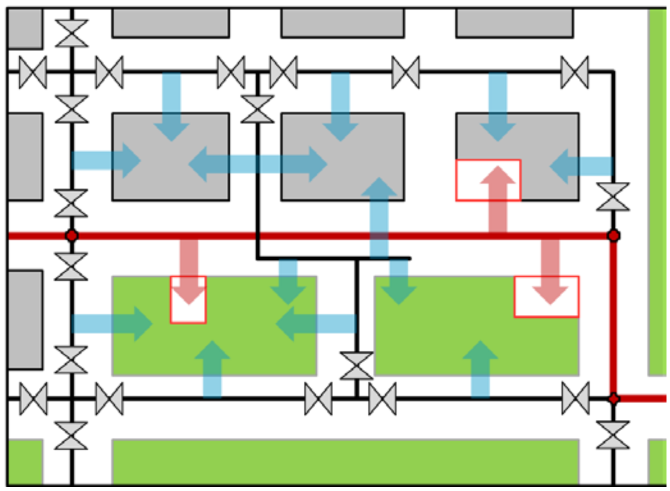
Multiple connections to the grid from different shutdown segments along the feeder can provide the grid with a redundant supply from the feeder that will tolerate a failure and shutdown of the feeder. See Figure 5-16.

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



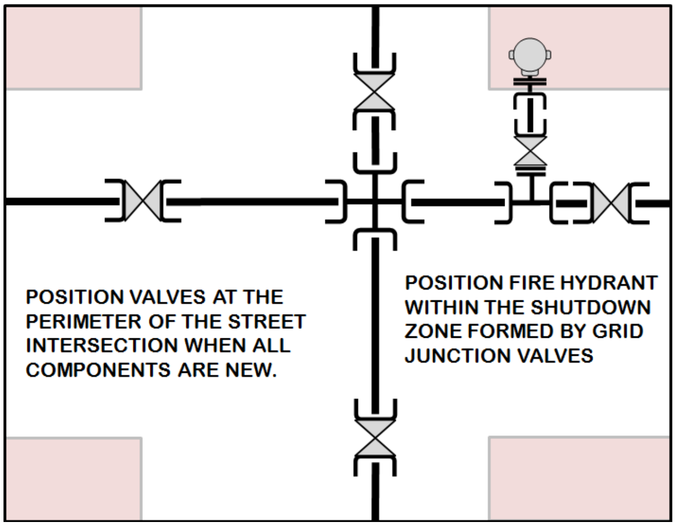
While reducing the number of customers and hydrants supplied by a large-diameter main will reduce the total impact of a shutdown involving the large main, the customers who are affected will experience the more lengthy service outage associated with taking a large main out of service. If the shutdown 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.

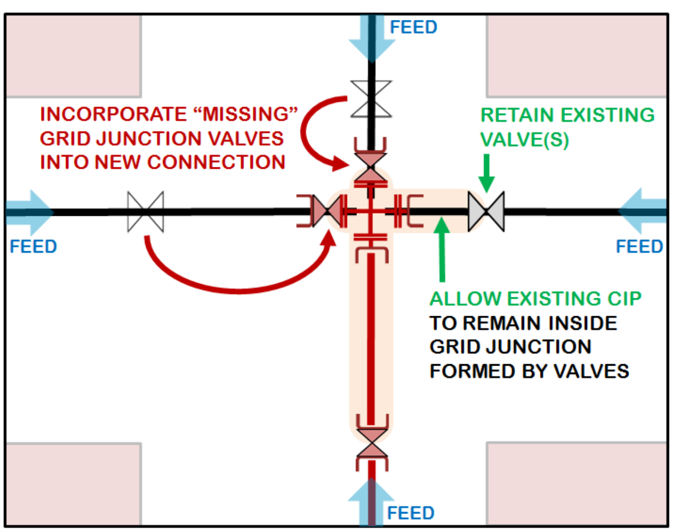
Figure 5-18
Default Positioning of Grid Junction Line Valves for All-New Construction



New Construction Connecting with Existing Cast Iron Distribution Mains

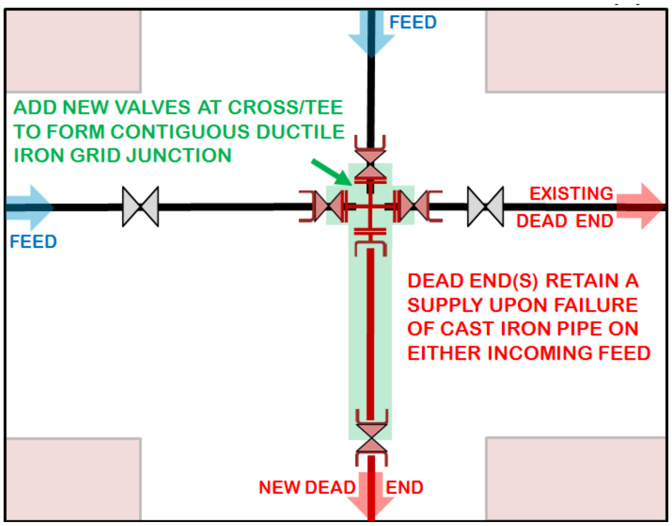
Looped system: When the new water main segment will form a supply loop (will receive water from two directions), then any grid junction created by the new water main can utilize the standard intersection valve positioning practices outlined under all-new construction. The new looped main can employ existing 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



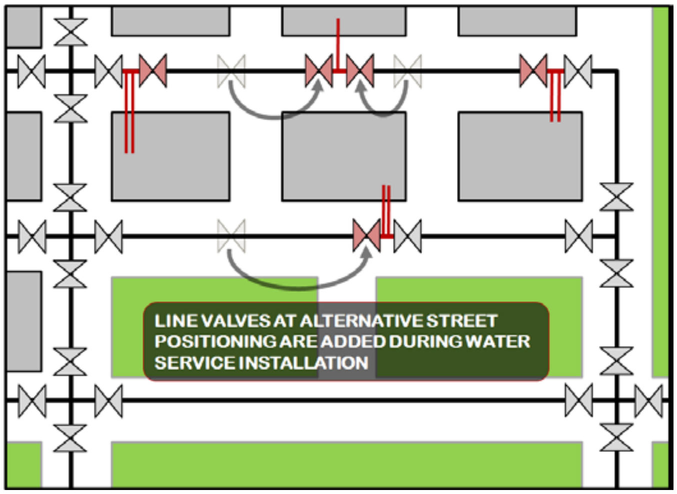
Single-feed system: When the new water main segment will form a dead end, or will provide the only standard-diameter supply to an otherwise dead end area, the grid junction need to be arranged to ensure that the dead end leg extending out from the grid junction will receive supply from at least to two 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 (≥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. Removed for security 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 Standard Spec 9-30.1(6)C. 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. Polyethylene encasement must be per Standard Spec 9-30.1(6) D. 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 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.

5.8.5 Rehabilitation of Existing Mains

See DSG section 5.6.5.

5.8.6 Emergency Pump Connections

See DSG section 5.6.6.

5.8.7 SCADA

See DSG section 5.6.7.

5.8.8 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. Removed for security 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

Parameter	Requirement	Comments
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.

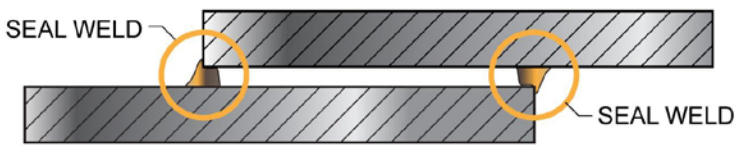
Note: *As of June 2015 SPU only has impressed current cathodic protection on the Trenton Stand Pipes and has a sacrificial cathodic protection system on the Foy Stand Pipe. On well coated tanks, sacrificial cathodic protection systems are preferable. The design engineer should consult with a corrosion 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 ½ 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

- <u>Each storage cell must have provisions for online measurement and recording of water levels between the top of the outlet sump and overflow levels</u>.
- 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. <u>All access hatches not bolted to the main structure must be lockable and provide intrusion switches linked to the SCADA system</u>.
2. Hatch lids <u>covering openings to water storage facilities</u> 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 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 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. <u>Gaseous chlorination systems must not be used</u>.

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 SEISMIC DESIGN

The seismic provisions for new SPU water system infrastructure are presented in this section. Design standards for new watermains are presented in Section 5.10.1. Seismic requirements for other types of SPU water system facilities usually fall under auspices of the Seattle Building Code (SBC). The application of the SBC seismic requirements to SPU water system facilities is discussed in Section 5.10.2. Dams and facilities needed to assure safe dam operation shall be designed in accordance with the appropriate regulations and methods as determined by SPU's Dam Safety Group.

5.10.1 Seismic Design Standards for New Watermains

This standard applies to new watermain construction, including new pipelines that are replacing existing pipelines. Existing watermains need not adhere to these standards unless they are rehabilitated or replaced.

5.10.1.1 Definitions

Table 5-10
Pipeline Definitions

Infrastructure	Description
Primary Backbone Pipelines	Transmission pipelines that convey water from the Tolt Reservoir or Lake Youngs Treatment Plant to the terminal reservoirs. Primary Backbone Pipelines are identified in Figures 5-23 and 5-24.
Secondary Backbone Pipelines	Transmission pipelines that convey water from the terminal reservoirs to distribution reservoirs or large service areas. Because Lake Youngs can supply the Cedar system for approximately four weeks, the transmission pipelines from the Landsburg Diversion to Lake Young are defined as secondary backbone pipelines. Secondary Backbone Pipelines are identified in Figures 5-23 and 5-24.
Hospital/Critical Facility Watermains	Watermains that are needed to supply hospitals or other critical facilities that must remain operational after an earthquake. Hospital/Critical Facility Watermains are identified in Figure 5-24.
Fire-fighting Mains	Mains needed to supply water to within 2,500 feet of anywhere in the City of Seattle. Fire-fighting mains are identified in Figure 5-24.
Ordinary Mains	All watermains that are not classified as backbone, hospital/critical facility or fire fighting mains.
Segmented Pipelines	The joining mechanism between pipeline segments creates a mechanical discontinuity between the pipeline segments. Examples of segmented pipelines include ductile iron pipe (including bell and spigot joined pipe, mechanical joints, earthquake joints, etc.) and bell and spigot joined PVC pipe.
Continuous Pipelines	The joints between pipeline segments are fused or welded together so that the mechanical properties and mechanism for transferring stresses through the joints is similar to mechanical properties and transfer of stresses through the pipeline segment barrels. Welded steel pipe with butt welded joints and fused jointed HDPE and PVC pipe are examples of continuous pipelines. From a seismic perspective, pipelines such as welded steel pipe with lap welded joints are considered a hybrid between segmented and continuous.
Permanent Ground Displacement (PGD) Susceptible Area	Those areas (see Figures 5-23 and 5-24) that are: 1. Identified by Palmer et al. (2004) as having a high- or moderate-to-high liquefaction susceptibility or peat area, or 2. Defined by the Seattle Department of Construction and Inspection to be in a Known or Potential Slide Area, or 3. Defined as a King County Landslide Hazard Area, or 4. Defined as a Washington Division of Geology and Earth Resources Landslide Area. If a geotechnical investigation shows that PGD is possible along the alignment, even though the alignment is not within one of the PGD-susceptible areas identified in Figures 5-23 or 5-24, then that pipeline shall be considered to be in a PGD-susceptible area. Alternatively, if a geotechnical investigation shows that the pipeline alignment is not susceptible to PGD, even though the alignment lies within a PGD-susceptible area identified on Figures 5-23 or 5-24, the pipeline may be designed as if it does not lie in a PGD-susceptible area.
Seattle Fault Zone	That area defined by Pratt et al. (2015) as adopted by Lettis Consultants International, Inc. (2016) as being in Zone A or Zone B as depicted in Figure 5-23.
SPU Intense Ground Shaking Region	The area within the SPU transmission and distribution region where the 0.02 probability of exceedance in 50-year ground motions are greater than or equal to 0.6g (see Figure 5-24).

5.10.1.2 SPU Watermain Seismic Design and Construction Requirements

The level of analysis and performance required for watermain design and construction shall be in accordance with the watermain criticality and earthquake hazard exposure as defined in Table 5-11. Primary and secondary backbone pipelines, hospital/critical facility and fire fighting mains are identified in Figures 5-23 and 5-24. For any pipeline, if a site-specific analysis shows a lesser level of design than that stipulated by Table 5-11 is adequate, then that pipeline need only be designed in accordance with the design indicated by the site-specific analysis.

Table 5-11
Minimum Watermain Design & Construction Analysis & Performance Requirements

Watermain Class/Criticality	PGD Area	Seattle Fault Zone or SPU Intense Ground Shaking Region	All Other Areas
Ordinary	Performance Specification 1	Performance Specification 2	No seismic requirements
Hospital/Critical Facility and Fire Fighting Mains	Performance Specification 1	Performance Specification 1	Performance Specification 1
Secondary Backbone	Site-specific analysis	Site-specific analysis	Performance Specification 1
Primary Backbone	Site-specific analysis	Site-specific analysis	Site-specific analysis

Note: For those pipelines that lie in both a PGD area and intense ground shaking region, the PGD area requirements govern.

A. Performance Specification 1 Requirements

In order to meet the requirements for Performance Specification 1, pipelines must meet the following ductility and strength requirements:

1) Segmented Pipelines (maximum segment length is 30 feet)

a. Axial Elongation (at each joint): 1% Minimum Axial Elongation or Shortening.

b. Axial Pullout Strength (of each joint): 17,100 pounds per inch of nominal diameter

c. Deflection (at each joint): 5 degrees of deflection per 20-foot segment. Prorate for shorter or longer segment lengths.

d. Segmented pipeline systems that meet the Performance Specification 1 requirements include, but are not limited to:

- Kubota Genex Earthquake Resistant Ductile Iron Pipe
- American Pipe Earthquake Joint Pipe

2) Continuous Pipelines

a. Welded Steel Pipelines with Butt-Welded Joints

Meet the requirements of AWWA C200 and

$$\frac{D}{t} \leq 100$$

Where D = the pipe nominal diameter in inches

t = the pipe wall thickness in inches (minimum thickness = 0.25 inches)

b. HDPE Pipelines – Meet the requirements of MAB-3-2017, AWWA C906 and ASTM F2620. Joints shall be butt-fused.

3) Pipeline Backfill/Bedding

Pipe backfill and bedding shall be as specified in Standard Plan 350 of Seattle Standard Plans for Municipal Construction. The use of Control Density Fill or other backfill/bedding that could restrict pipe movement is not permitted unless Control Density Fill is absolutely necessary due to site conditions, restraints or third-party requirements, and approved by the pipeline engineer. The bedding requirements are also waived for earthquake resistant HDPE pipe that is installed by horizontal directional drilling.

4) Corrosion Protection

For metallic pipelines required to meet these seismic design standards, corrosion protection must be provided and maintained for the life of the pipeline to maintain the long term desired seismic performance. See Chapter 6 of SPU's Design Standards and Guidelines.

5) Hydrants

For hydrant runs in PGD areas, accommodation shall be made within five feet of the hydrant connection to allow for a minimum of five degrees of deflection and 2 inches of both expansion and contraction (4 inches minimum total) between the main and hydrant. Hydrant connection piping shall be restrained joint ductile iron, welded joint welded steel or HDPE with thermally fused joints. Hydrant connection details in PGD areas should be shown on the project plans.

Examples of acceptable joint systems that meet these requirements include

1. One American Pipe earthquake joint/fitting
2. Two US Pipe TR-Extreme S1 joints/fittings (one of which should be within five feet of the hydrant connection tap)
3. One Kubota GENEX fitting
4. One US Pipe SAM1 fitting
5. One EBAA Iron Flex-Tend fitting

6) Services

The following practices are not required but are highly recommended in areas susceptible to permanent ground displacement as identified in Figure 5-24:

1. Provide enough slack in copper water services to provide a minimum of 6-inches watermain movement at the connection or

2. Use an oversized corporation stop and embed the service line in a minimum of twelve inches by twelve inches of pea gravel that extends a minimum of three feet back from the watermain.

7) Vaults

Flexibility shall be provided near the interfaces where ductile iron pipelines are connected to vaults or valves (or valve boxes). Within five feet of vault or valve interface, an earthquake-resistant joint capable of providing a minimum of:

1. Five degrees of deflection in any direction
2. 2.4 inches of axial expansion and contraction (4.8 inches total)
3. Joint strength of 17,100 pounds multiplied by the pipe diameter (inches)

Examples of acceptable joint systems that meet these requirements include

1. One American Pipe earthquake joint/fitting
2. Two US Pipe TR-Extreme S1 joint/fitting (one of which should be within five feet of the vault)
3. One Kubota GENEX fitting
4. One US Pipe SAM1 fitting (because the deflection and axial expansion/contraction capabilities of the SAM1 fittings greatly exceed requirements #1 and #2, requirement #3 is waived)
5. One EBAA Iron Flex-Tend fitting (because the deflection and axial expansion/contraction capabilities of the Flex-Tend fittings greatly exceed requirements #1 and #2, requirement #3 is waived)

The full manufacturer’s recommended allowable deflection minus the installed deflection must be greater than the minimum required deflection

8) Connections Between Distribution Mains and Transmission (Backbone) Pipelines

A minimum of five degrees of deflection in any direction and 2.4 inches of axial lengthening or shortening should be provided in the distribution main within five feet the distribution main’s connection point to the transmission pipeline

B. Performance Specification 2 Requirements

The following pipelines are permitted in Performance Specification 2 areas:

1. Restrained joint ductile iron pipe that conforms to the City of Seattle Standard Specifications and Plans. Additionally, for restrained joint ductile iron pipe that is being restrained only to address seismic concerns, Series 1100 MegaLug mechanical joint restraints are acceptable.
2. Welded steel pipe joint with either lap or butt welds
3. HDPE pipe that meets the requirements of AWWA C906 and ASTM F2620
4. Restrained joint, AWWA C909 molecularly oriented polyvinyl chloride pipe (PVCO).

C. No Seismic Requirements

New pipelines need to only meet SPU non-seismic specific requirements.

D. Site-specific Analysis

The site-specific analysis shall meet the following minimum requirements:

1. Geotechnical hazards shall be identified and evaluated along the pipeline alignment.
    a. Geotechnical hazards shall be consistent with those hazards that would occur from 0.02 probability of exceedance in 50 years (2475 average return interval) ground motions.
    b. Geotechnical hazards shall include transient seismic wave propagation/ground shaking hazards and PGD hazards.
2. The pipeline shall be designed and constructed to resist and accommodate the forces and ground motions/displacements along the alignment determined in Step 1. The following criteria must be met:
    a. The pipeline shall remain operable during and after the seismic event.
    b. Inelastic behavior, possibly requiring eventual repair or replacement, is allowable providing the pipeline can remain operable until the post-earthquake emergency conditions have passed.
    c. The larger of either the mean or medium values of the estimated geotechnical hazards (e.g., permanent ground displacement, peak ground velocity, etc.) shall be used in the analysis.
    d. A factor of safety equal to 1.0 may be used.

E. Connections to Existing Pipe

When earthquake resistant pipe is installed and connected to existing pipe then

1. If the existing pipe is already earthquake resistant pipe that meets this standard, then the fitting/connection must also meet this standard.
2. For all other cases, the connection/fitting to existing pipe does not need to meet this standard's earthquake requirements.

F. Repairs in Alignments That Require Earthquake Resisting Pipe

1) Emergency Repairs

For repairs that must be made as soon as possible (emergency repairs), the repair does not need to meet the seismic requirements described in this standard. If earthquake resistant pipe and/or joints are available, repairs to existing earthquake resistant pipe should be made with earthquake resistant pipe, when feasible. For critical and backbone pipelines, if the existing pipeline consists of earthquake-resistant pipeline and the repair is not made with earthquake resistant pipe, the non-earthquake resistant pipe repair should be replaced with earthquake resistant pipe in accordance with the non-emergency repair requirements within one year of the emergency repair.

2) Non-Emergency Repairs: Two or Less Twenty-Foot Pipe Segments Repaired

If the existing pipe is not earthquake resistant pipe, then the repair may be made without regards to the seismic requirements in this standard. Repair documentation should note that the repair does not meet the seismic requirements and the repaired sections should be replaced with earthquake resistant pipe when the surrounding pipe is replaced by earthquake resisting pipe.

If the existing pipe is earthquake resistant pipe, the repaired pipe joints need to be strong enough to transfer the seismic forces to the remaining earthquake resistant pipe (e.g., if the pipe is ductile iron pipe, the repair pipe joints and joints connecting to the existing earthquake resistant pipe need to meet the ISO 16134 Slip-out Resistance Class A requirements) but the repair pipe does not need to be earthquake resistant pipe.

3) Non-Emergency Repair: More Than Two Twenty-Foot Pipe Segments Replaced

If the existing pipe is not earthquake resistant pipe but the alignment is located in an area that requires earthquake resistant pipe, the repair should be made with earthquake resistant pipe, when feasible. If it is not practical to make the repair with earthquake resistant pipe, then the repair should be replaced with earthquake-resistant pipe when the adjoining pipe is replaced with earthquake resistant pipe.

If the existing pipe is earthquake resistant pipe, then the repair should be made with earthquake-resistant pipe.

G. Installation of Earthquake Resistant Ductile Iron Pipe

Earthquake resistant ductile iron pipe should be installed per the manufacturer's recommendations. Typically, earthquake resistant ductile iron pipe joints will be set in the neutral position (joints permit equal amounts of contraction and expansion, and joint can deflect equally in all directions). If seismic hazard characteristics warrant, the joints may be set in a nonneutral position. In order to accommodate alignment curvature requirements, the pipe joint may be deflected up to 50% of the design deflection limit if the alignment is on level ground. If the pipeline alignment is on sloped ground and the slope may displace in a direction that would cause the pipeline alignment's radius of curvature to decrease (bend more), then the pipeline segment lengths should be shortened or ball joints should be provided so that the Performance Specification 1 joint deflection requirements are maintained in the direction of the expected slope movement.

Earthquake resistant ductile iron pipe joints can extend and contract in the axial direction. Similar to ball joints, earthquake resistant ductile iron pipe joints can also deflect. Thrust blocking that is similar to the thrust blocking that is used for segmented pipelines with unrestrained joints should be provided. Thrust blocking must also be provided at fittings and hydrants where unbalanced hydraulic loads may occur.

Thrust collars should be used for valves in earthquake resistant pipe alignments. The valves should be flanged and a flange by restrained joint adapter should be used to connect the valve to main.

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5.10.1.3 Commentary

The commentary is provided as guidance on how to satisfy the intent of the water pipeline seismic design standards.

A. Performance Philosophy

The intent of these standards is to eliminate most, but not all, water main damage. Earthquake resistant pipe that meets Performance Specification 1 requirements has withstood most earthquake-induced liquefaction, lateral spread, landslide and settlement hazards. If earthquake resistant pipe is used for all pipe in permanent ground displacement susceptible areas, most but not all pipe damage would be prevented in these areas.

Because earthquake resistant pipe is more expensive than non-earthquake resistant pipe, non-earthquake resistant pipe is permitted in areas that have not been identified to be susceptible to permanent ground displacement (approximately 80% of the direct service area). There would likely be some areas where ground displacements occurred in areas that had not been identified to be susceptible to ground displacement. Some pipe damage from transient wave propagation effects or unexpected permanent ground displacement would be expected in areas that had not been identified to be susceptible to permanent ground displacement. Although some pipe damage would occur throughout the system, this damage would not significantly disrupt the system and could be repaired relatively quickly.

Because more reliability is needed for critical and backbone pipelines, Performance Specification 1 is the minimum requirement for all critical and backbone pipelines, regardless of the expected geotechnical conditions. Performance Specification 1 pipelines would also be much more reliable if there is intense ground shaking or ruptures from surface faulting.

B. Surface Rupture from Faulting

Surface rupture is possible during a large Seattle Fault or South Whidbey Island Fault event. The Seattle Fault zone is approximately 7 kilometers wide. Surface faulting could occur anywhere within this zone and could result in discrete surface displacements as large as three meters and distributed surface displacements of six meters (e.g., see Lettis 2016). Pipelines that are not specifically designed to resist these large displacements at the specific location that the displacement occurred would likely fail. Because there is so much uncertainty on where surface faulting may occur, it is not feasible to reliably design all pipelines against surface faulting in the Seattle Fault zone. As earthquake resistant pipe evolves and becomes less expensive, and the understanding of the crustal fault systems in the Puget Sound area increases, these standards will evolve. The current strategy considers that:

- For ordinary watermains, it is not feasible to design for fault ruptures across the entire Seattle Fault zone that would only occur across a small minority of pipelines. Because there may be intense ground shaking, Performance Specification 2 pipe is mandated throughout the fault zone. As earthquake resistant pipe evolves and becomes less expensive, in the future, this standard may be modified to require new ordinary mains to meet Performance Specification 1 requirements throughout the fault zone.
- For critical watermains, Performance-Specification 1 earthquake-resistant pipe must be used as minimum in all areas and the pipe would likely accommodate

small surface faulting. It is not feasible to design for large surface fault displacement throughout the fault zone. There would be some failures if large surface ruptures occur, but it would be more cost-effective to have procedures and materials to quickly repair these breaks than to try to prevent them throughout the entire fault zone.

- Backbone pipelines are exposed to possible surface faulting in the Seattle and South Whidbey Island Fault Zones. For backbone pipelines, the intent is to use pipeline systems that can handle small discrete offsets (e.g., less than a foot) or larger, more distributed offsets. Because larger discrete offsets may occur almost anywhere in the fault zones and it is not economically feasible to design entire alignments through the fault zone to resist such large discrete displacements. Consequently, emergency preparedness and response measures such as having the necessary repair resources readily available in case a large, discrete offset does occur across a pipeline alignment must be relied on.

C. Site Specific Analysis

Site specific analysis is intended to include an assessment of the geotechnical hazards that may affect the pipeline alignment and the pipeline response to these geotechnical hazards. The level of detail needed for the site specific analysis should be commensurate with the site characteristics. For example, if the pipeline alignment is located in an area without any apparent geotechnical hazards, the geotechnical engineer may be able to look at the site and available geotechnical data and then draw conclusions about the site without any detailed analyses. A pipeline engineer may also be able to specify the needed pipeline performance requirements/type without a detailed analysis. Alternately, both detailed geotechnical and pipeline analyses may be warranted if the geotechnical conditions suggest there may be large permanent ground displacements that may require more than typically available earthquake resistant pipe.

D. Hydrant Runs

Differential movement between the main and hydrant/hydrant piping can result in pipe failure. An earthquake joint within the hydrant pipe run can substantially reduce the likelihood of pipe failure. This joint should be placed as close to the main as feasible, and, if possible, between the main and hydrant piping valve. A thrust block is needed behind the hydrant foot to maintain the neutral position of the seismic joint. If the designer wishes to achieve a much higher degree of reliability, more specialized joints with extra telescoping and defection capability should be considered than the criteria listed in this standard.

E. Services

Service line failure caused by differential movement between service lines and watermains is a common earthquake failure mechanism. Different water utilities around the world have suggested various measures to increase water service seismic resiliency. HDPE services are commonly used in Japan, Taiwan has suggested using stainless steel bellows and a boot that would allow the service to move freely was suggested for a California utility. HDPE services are probably more flexible and seismic resistant than copper, but copper is the current SPU standard. Copper is somewhat flexible but not as seismic resistant as HDPE. Providing an expansion/contraction loop, an extra copper loop, flexible tubing or more flexible bedding at the service tap would likely increase service line resilience. In the future, the water industry may develop a more definitive standard for water services.

5.10.1.4 References

Lettis Consultants International, 2016, Final Desktop review and Summary of the Seattle and South Whidbey Island Fault Zones for Seattle Public Utilities.

Palmer, Stephen P., et. Al., 2004, Liquefaction Susceptibility and Site Class Maps of Washington State, By County, Washington Division of Geology and Earth Resources, Open File Report 2004-20.

Pratt, T.L., Troost, K.G., Odum, J.K., and Stephenson, W.J., 2015, "Kinematics of Shallow Backthrusts in the Seattle Fault Zone," Washington State: Geosphere 11, No. 6, doi.10.1130/GES01179.1.

5.10.2 Seismic Design of Buildings, Tanks/Reservoirs. Other SPU Water System Structures and Nonstructural Elements

Seismic provisions for buildings, tanks, reservoirs, nonbuilding structures and nonstructural elements are covered by the International Building Code (IBC). Some IBC seismic requirements are directly stated in the IBC. Other IBC seismic requirements are contained in standards such as ASCE 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures that are referenced by the IBC. The Seattle Department of Construction and Inspections (DCI) modifies some IBC requirements but typically adopts most of the IBC into the SBC.

The SBC is the minimum acceptable design level. There may be some instances when more stringent design requirements are appropriate. Outside the Seattle city limits, King County Building Code Requirements must also be met. Because King County also adopts the IBC, the King County Building Code requirements are similar to the SBC. In order to allow designers the greatest flexibility in addressing each design, the SPU Design Standards and Guidelines do not specify means and methods for satisfying seismic design requirements.

5.10.2.1 Building Occupancy Category

Seismic design requirements are a function of building occupancy/criticality. Facilities that must remain functional are classified as essential facilities by the IBC. SPU building and nonbuilding structures, including:

- Tanks and Reservoirs
- Pump Stations and Wells
- Support Facilities (offices, warehouses, repair and maintenance, etc.)
- Pipeline Support Structures and Vaults

shall be classified as essential facilities.

Office facilities are considered essential facilities because these offices are needed to house staff that is essential to operating the water utility. Redundant facilities or facilities that are not essential to water system operation do not need to be designed as essential facilities.

5.10.2.2 Nonstructural Elements

Nonstructural elements include building structure components (e.g., suspended ceilings, partition walls, etc.) and contents (e.g., motor control centers, storage lockers, building piping, etc.). Nonstructural element anchors, supports and braces shall be designed in accordance with the Seattle Building Code (which references the IBC and ASCE 7).

The importance factor used in design shall be as specified in ASCE 7. Note that

1. Containers with hazardous substances or substances that may combine with other substances located in the same area to create hazardous substances shall be anchored or restrained to prevent the containers from releasing the stored contents.
2. Furniture and other components such as computers that are often moved need not be anchored providing the unanchored elements
    a. Cannot fall and create an injury hazard or block egress routes
    b. Are not needed to remain operable in order to maintain functionality of an essential facility.
3. Suppliers of mechanical and electrical equipment that must remain operable in order for an essential facility to function need to certify the equipment will remain operable (see ASCE 7).

5.11 CONSTRUCTION

The section describes design considerations for construction of water system infrastructure.

5.11.1 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.

5.11.1.1 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 5-13). Pipe with lead joints in older mains is susceptible to leaking and at high risk of failure if exposed to these activities.

Table 5-12
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

Condition	Occurs When and Where	Pipe Protection Measure
	Paving construction where excavations have reduced the cover over pipes	Bridging Pipe relocation
Vibration & Settlement	Dewatering of soils with higher water content around or adjacent to pipes Trench excavations adjacent to water pipes, e.g. excavations for sewer mains or duct banks that result in soil loss Tunneling and other large open excavations Excavations for other utilities below water pipes Vibration from construction equipment, e.g. driven piles, sheet piles, or stone columns Excessive loads Landslides	Temporary pipe supports Shoring of adjacent deeper trenches, as applicable Use drilling methods for the installation of shafts / columns instead of vibratory methods to the extent practicable Establish clear tolerances for acceptable pipe settlement and provide field monitoring for settlement
Thrust restraint	Excavations behind thrust blocks (loss of bearing surface behind the thrust block) Excavation and exposure of water pipes that are under pressure (loss of pipe surface friction component of thrust restraint)	Locate thrust blocks prior to construction Avoid disturbing thrust blocks to extent practicable Use temporary thrust blocks or collars Avoid exposing pipes that are under pressure 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.
Contamination	Exposed water pipe joints w/in trench excavations that can fill w/ runoff or ground seepage water, particularly if main is depressurized Exposed water pipe joints within common trench excavations that have an active sewer main, particularly if water main is depressurized	Control runoff water to trench Sump pumps

5.11.1.2 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.

5.11.2 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.

5.11.2.1 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 5-13.

Table 5-13
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.

5.11.3 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.*

5.11.3.1 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.

5.11.3.2 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 5.11.4.

5.11.3.3 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. Removed for security

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

5.11.3.4 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.

5.11.4 Customer Impacts and Service Disruptions

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5.11.4.1 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.

5.11.4.2 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.

5.12 OPERATIONS & MAINTENANCE

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5.12.1 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. <u>Easements must be project-specific</u>.

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 5-14 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 5-14
SPU Minimum Water Easements

Inside Pipe Diameter or Nominal Pipe Diameter (inches)	Minimum Easement Width (feet)
<8 to 24	20
30 to 92	30

5.13 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

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13. Seattle Public Utilities; Water System Plan – 2013. Removed for security
14. Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal. Najafi, Mohammad, PhD, PE. WEF Press, 2004
15. Performance Based Seismic Design for LADWP Water System Final v1.0
16. Final Summary Report Water System Seismic Resilience and Sustainability Program for LADWP

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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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Contents

List of Figures

List of Tables

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.

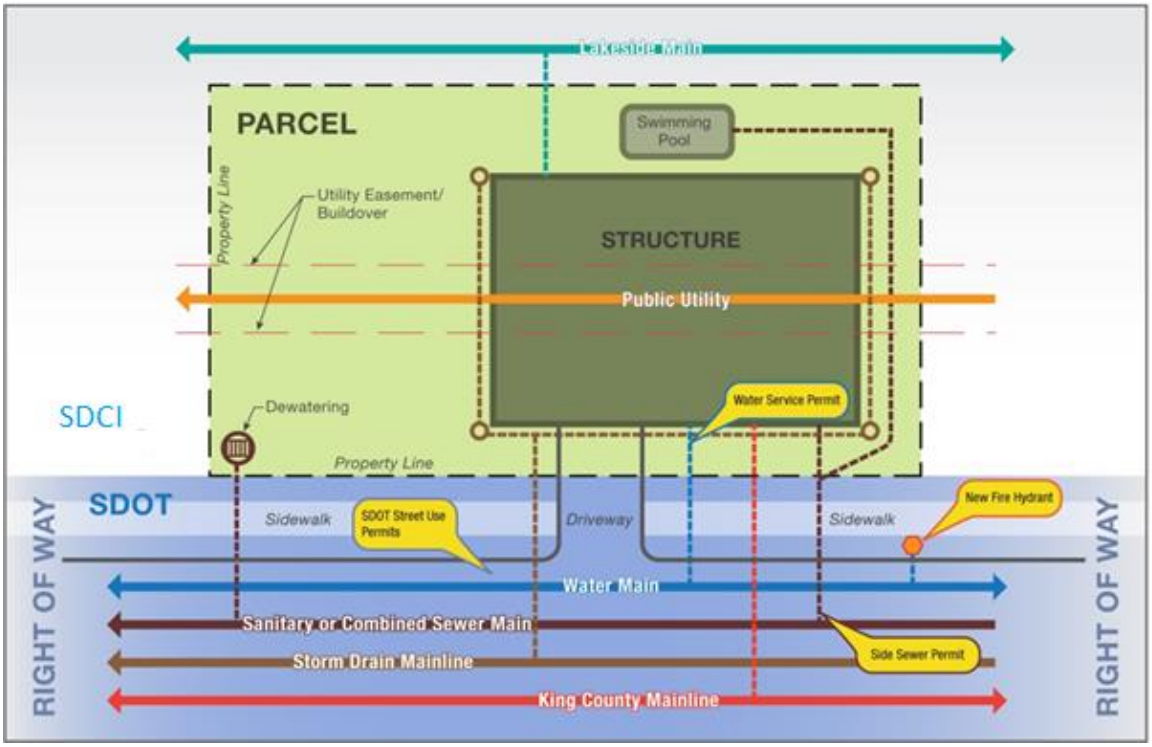
18.3.1 Private Development Projects

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:
	  o If more than one possible connection point, the reviewer may suggest preferred pipe and location of connection.
	  o 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

18.5.1 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.

18.5.1.1 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.

18.5.1.2 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.

18.5.2 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.

18.5.3 Latecomer Agreements

Latecomer agreements are also applicable to water main extensions. Please see above section 18.4.9 for more information.

18.5.4 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.*

18.5.4.1 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.

18.5.4.2 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 SDCI. In order to become more customer friendly, SDCI 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 SDCI. 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. ≥2,000 sf new and replaced impervious surface, or
   b. ≥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. ≥1,500 sf new and replaced impervious surface or ≥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 ≥ 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.

Position Description	Responsibilities
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. • Involve SPU as needed or agreed in the permitting process.
SCL	Plan Review Team	Review	• 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.

Organization	Group	Role	Responsibilities
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

Department/Branch	Issues for Coordination
	• 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: o Interpretation of the Stormwater code for on-site drainage review o Side sewer permitting o Main extension requirements o Temporary construction discharge o Build-over or relocation inspections permitted by SDCI o 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 • 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
Side Sewer Code (2010) SMC Chapter 21.16	Regulates construction/use of service drains and side sewers in Seattle.
Stormwater Code(2016) SMC Chapter 22.800	Regulates stormwater, flow control, water quality, temporarily during construction, and permanently after construction.
Water Code (2007) SMC Chapter 21.04	Regulates current and future water demands, ensures high quality drinking water, and establishes rates for purveyors and customers.
King County Code KCC Title 28	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
2011-004	Requirements for Design and Construction of Side Sewers (Drainage and Wastewater Discharges
2011-005	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. There is an Agreements Library located on PDEB SharePoint site.

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	
TIP 502	Grading Regulations in Seattle
TIP 503	Side Sewer Permits in Seattle
TIP 504	Side Sewer As-Built Plan Requirements
TIP 506	Side Sewer Permits for Temporary Dewatering on Construction Sites
TIP 507	Build-over and/or Re-route Review and Approval Process
Tip 520	Rainwater Harvesting for Beneficial Use - Green Building CAM
SPU CAMS	
CAM 1101	Drainage and Wastewater: Regulation of Development
CAM 1102	Sewer Sub-meter Program
CAM 1180	Design Guidelines for Public Storm Drain Facilities
CAM 1201	Water Availability Certificate
CAM 1202	Water Service Application
CAM 1301	Solid Waste: Information for Developers
CAM 1302	Building Material Salvage and Recycling
CAM 1401	SPU Survey Requirements
CAM 1402	Survey Monument Protection
SDOT CAMS	
CAM 2200	SDOT Street Improvement Permitting (SIP) Process
CAM 2201	90% Complete Street Improvement Plan Requirements
CAM 2213	60% Street Improvement Plan (SIP) Approval Process
CAM 2214	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

Activity Code	Title
N437002	Other Plan Review
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	SPU

Software Name	Description	Owner
	other reviews that occurs in the Plan Review Section. Write access is 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.	
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	
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
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 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)
Tip 107 SDCI Public Records	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	Tip107
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 DWW information	Water Service Project Leads (206-684-3333), 700 5th Avenue, 27th 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 47th Floor Sewer and Drainage counter at SDCI
SPU Engineer's Maps		See base maps
Sewer & Drainage Infrastructure Map Sheets		Seattle Map Counter Public Resource Center, SMT 22th 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. The map corrections forms for water and DWW data are located online.

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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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Seattle Public Utilities

Director's Rule

Title	Number	Rev. no.
Standard, Connection, and Administrative Charges—Water	FIN-210.2	1
Responsibility	**Supersedes**	**Pages**
Finance Division	N/A	19
SPU Directors's Approval	**Effective Date**	
Ray Hoffman	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**
	Residential	*Arterial*	
3	**Cost ***	**Cost ***	**$11,693**
4	**Cost ***	**Cost ***	**$18,071**
6	**Cost ***	**Cost ***	**$35,079**

Fire Only Services

Size (inches)	**Installation Fee**		**Connection Charge**
	Residential	*Arterial*	
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**	
	Residential	*Arterial*
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**	
	Residential	*Arterial*
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**
Pseudomnonas (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, Tl, Zn

~~***Titrations***~~

~~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 (comparitor, colorimetric).......... **$12**~~

~~Fluoride (potentiemetric).......... **$16**~~

~~Iron (colorimetric comparitor) .... **$12**~~

~~pH, potentimetric .... **$16**~~

~~Specific conductance.......... **$12**~~

~~Turbidity.......... **$10**~~

~~Chlorine Residual, colorimetric .... **$12**~~

~~Chlorine Demand~~

~~Single contact time at the requested temperature, pH, and Cl2 dosage .... **$113**~~

~~For each additional contact time, temperature, pH or Cl2 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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Seattle Public Utilities

Policy and Procedure

Title	Number
Water Availability Certificates (WACs)	CS-101
Responsibility	**Supersedes**
Drinking Water Division	2003 version
SPU Director's Approval	**Effective Date**
Ray Hoffman	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.

*Unio*n 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: [signature]	**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-2inches
- ♦ 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 alsoPolicy _________ 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.